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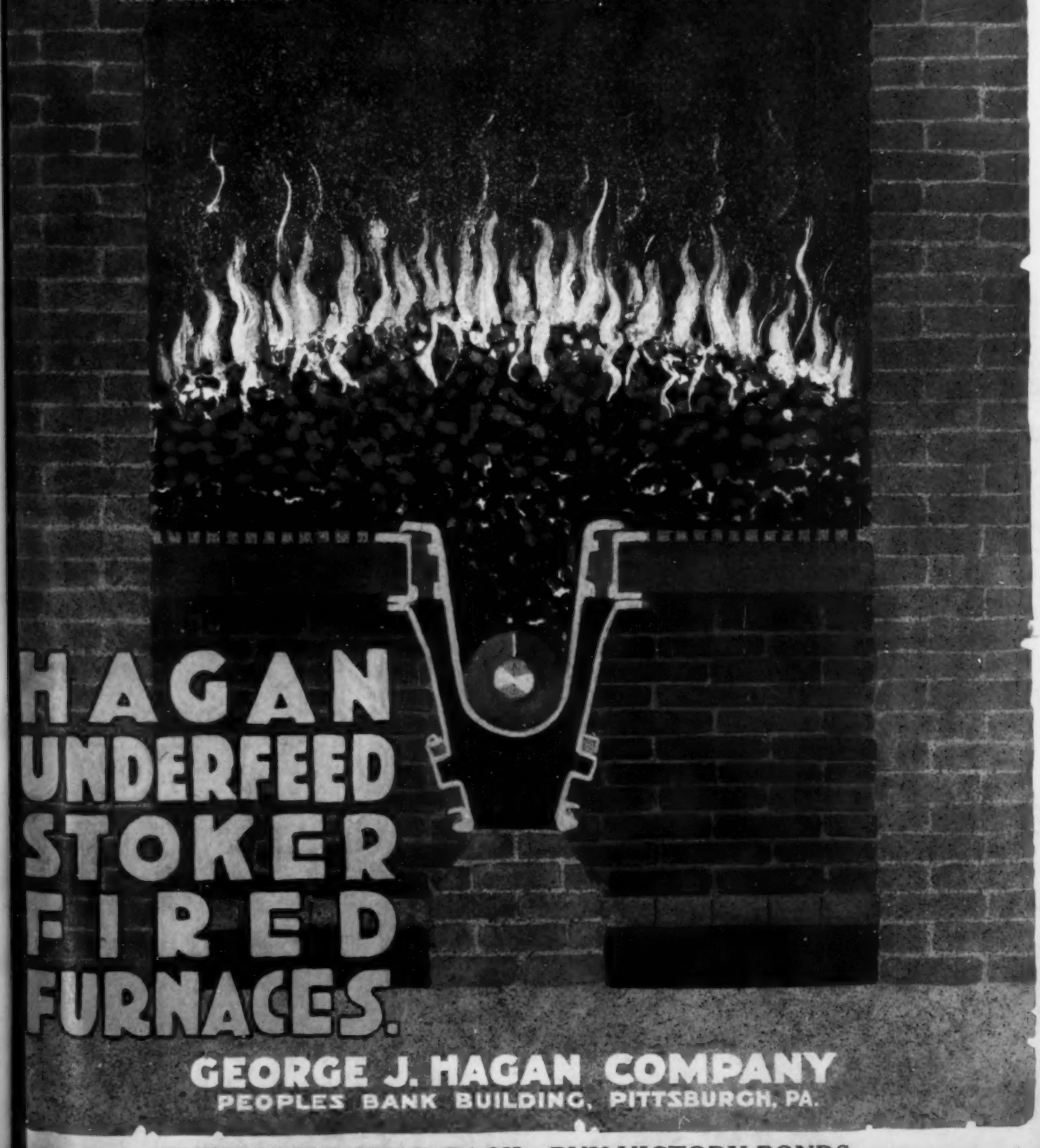

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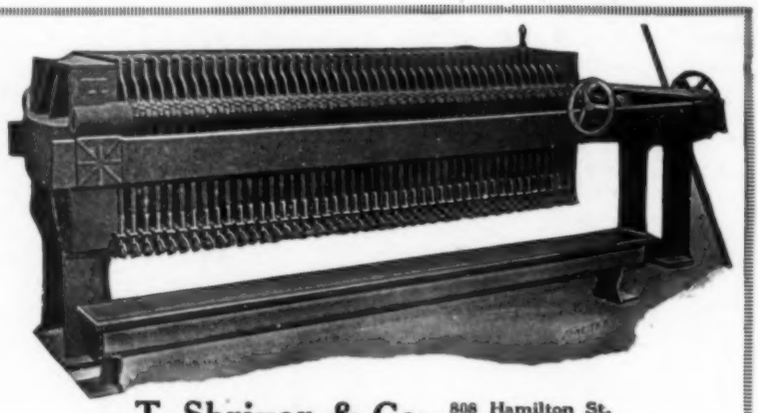

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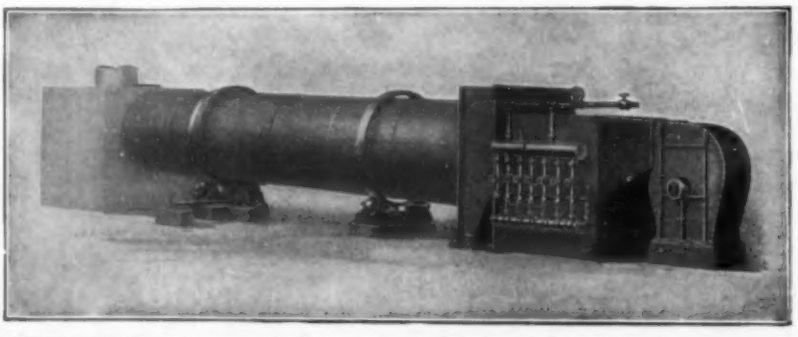

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The Passing Of a Friend

IN THE passing of J. E. JOHNSON, JR., we sustain a personal as well as a professional loss. For him we could have wished a more peaceful transition instead of the sudden and accidental death which resulted from being struck by an automobile. For him also we should have desired most earnestly a longer life, well rounded in experience and rich in the honors which inevitably would have come later to one who earned them by sheer merit in his earlier years. The morning and noontide of his life were inspiring, filled with the joy of achievement; that there should have been no afternoon and twilight years, with a peaceful setting of the sun, fills one with pity and regret.

In personality MR. JOHNSON was a virile, dynamic force. Always incisive and direct, he had opinions, expressed them forcibly, and left no doubt as to where he stood. Professionally he made an impression which will be felt and recognized more and more as the years go by. Readers of this journal will recall his serial contributions on the iron blast-furnace and the smelting of iron, which later appeared in book form. To his ability there is ample testimony in the mouths of leaders in the profession, from one of whom, MR. BRADLEY STOUGHTON, we are glad to receive and publish elsewhere in this issue a sincere appreciation.

Wanted: A Guardian For the United States

WRITING in the March *Atlantic* under the title "Developing the Estate," MR. ARTHUR D. LITTLE portrays the American people and their country in terms of an old homestead, heavily mortgaged but rich in resources that need intelligent and conservative development. The picture is alluring as we contemplate the "aggregation of undeveloped empires" which constitute our United States, but also appalling when we are reminded of the "long riot of waste and destruction" that has characterized the handling of our estate. The article makes wholesome reading, and it should be widely circulated for the influence it will have in creating a public conscience on a subject too little understood.

As we see it, the duty of creating this conscience devolves squarely upon scientists and technologists. As long as the people see in a lump of coal only a piece of dirty fuel, so long will they handle it wastefully and refrain from protesting against extravagant and uneconomical use. But let them visualize the vast chemical cosmos that exists in that same lump of dirty fuel—the potential heat, light, power, dyes, explosives, medicines and what not—and then realize that our supplies are not limitless, and we will have a moral force that will not tolerate prodigal waste. But who shall

give the people this new vision if not the men of science to whom the facts are known? Similarly we need to be aroused to a lively sense of our timber waste, our low agricultural yields, our undeveloped water power and the importance of all these things to each of us. Really, the problem of reconstruction, of which we have had so much aimless and fruitless talk, becomes a question of intelligent development of our estate.

MR. LITTLE leaves one with the impression that UNCLE SAM needs a guardian in the form of an economic commission to administer the estate and see that the people get the most out of it. The suggestion is a large one and particularly timely, for co-ordinated development is the order of the day in smaller things and should be applicable on a national scale. We are glad to lend our support to the idea.

Railroads and Industrial Research

A CORRESPONDENT takes us to task for chiding the Railroad Administration on its failure to support industrial research as developed under private ownership. "Has it not occurred to you," he says, "that a man holding a bear by the tail, wishing he might let go, but afraid to do so, has no time to think of methods of animal training whereby the bear might be improved?" We confess to a mental lapse. In our zeal for the support of industrial development we overlooked the Administration's predicament. With a rapidly and steadily accumulating deficit instead of the promised surplus, it faces the unpleasant duty of raising rates and thus increasing simultaneously its revenue and unpopularity. Its earnest desire undoubtedly is to get the companies in such shape that it can relinquish its hold and pass them back to the owners—a consummation devoutly to be wished. When that time comes we can expect further attention to industrial research and development which has contributed so much to the country's prosperity.

Chemical Industry And the Victory Loan

SOME months ago we hazarded the opinion that the fourth Liberty loan would be a Victory loan, and so it proved in effect. But the expenses of making war on a huge scale were not to be stopped with the arrangement of an armistice, and so the Government finds it necessary to float a Victory loan this month.

The chemical industry has a peculiar interest in this loan, because in the act of Congress authorizing the Secretary of the Treasury to issue the notes it was provided that $1,000,000,000 should be utilized in extending credits to firms desiring to develop South American markets. Moreover, it was provided that this credit might also be extended to banks and trust companies for use in financing such trade.

We feel quite certain that the German hold on the chemical markets of the United States has been broken by the Allied victory; and thanks to the activity of the Alien Property Custodian, the German-controlled chemical firms in this country have been transferred to American buyers. The domestic field is again open to the local industry. But a domestic field is not going to be large enough to absorb our products, and foreign markets must be opened, exploited and held. The infant chemical industry of the United States can scarcely expect to invade Germany; and England, France and Italy will not permit much European competition from American chemists. South America, however, will be open to us. The former German hold there has been shaken, and in the next decade South America will be one of the important commercial battlegrounds of the world. With the financial aid promised from this Victory loan, it would seem as though American chemical industry should secure its full share of the business in the southern markets.. For this reason chemists everywhere should take not only a vital interest in the success of the loan but also an active part in the campaign.

The Philosophy of Buying At Present High Prices

PROFESSOR IRVING FISHER of Yale University made an address before the Conference of Governors and Mayors at the White House on March 3-5, on "The New Price Revolution." The substance of his address was that prices have gone up for keeps, and there's no use waiting for them to go down, because they will not. Business, he said, is stalled and depression threatens because, well, to use a familiar expression which Dr. Fisher didn't, business is on the spring-board, swinging its arms but afraid to jump in. The merchant, he said, is selling, but not buying. The belief that prices will drop is putting a brake upon the entire machinery of production and distribution. Readjustment waits, because we keep on waiting for it.

The speaker is a man of vision and ingenuity, and he is very often right. He insists that we are on a permanent higher price-level, and he holds that the sooner the business men of the country take this view and adjust themselves to it the sooner will they save themselves and the nation from the misfortune which will come if we persist in the present false hope. The general level of prices, he says, is dependent upon the volume and rapidity of the turnover of the circulating medium in relation to the business transacted by it. "If the number of dollars," he explains, "circulated by cash and by check doubles, while the number of goods and services exchanged thereby remains constant, prices will be about double."

This seems to us a good definition of high prices, rather than an explanation of how they came about, but he adds that new money is what causes the increase. He notes the price revolution in the Sixteenth Century, due to the influx of gold and silver from the New World. Prices went way up, and people talked then of a temporary inflation, just as they do now. Similar sequelæ attended the increases in gold production in 1896 and 1914.

We have not space to include his review of the credit situation, except to note that the gold supply of the United States as a basis for credit has increased to such an extent that the ratio of gold to credit has risen since 1914 from 9.6 per cent to 15.3 per cent. The credit instruments of 1918 he records at $11,700,000,000, and notes that there is free gold to support a superstructure of 70 per cent as large as the existing one. He claims that the gold will not return to circulation, nor will there be a great outflow of gold through international trade. The hope that a resumption of international trade will lower prices is found to be false because European prices have risen more than ours, and they are no more likely to fall there than here.

DR. FISHER holds that there will be a vast increase of deposit banking in Europe; that the war has already brought money out of hoardings and into banks. A

consequent expansion of media of exchange will therefore take place, even in such faraway countries as India and China, which means a new habit leading to credit expansion and higher prices. This discovery of deposit banking in these countries is equivalent, economically, to a new source of gold supply.

Finally, DR. FISHER holds that to talk reverently of 1913-14 prices to-day is to speak a dead language; that new price-levels are a stubborn reality, and that the sooner merchants and manufacturers begin to stock up the better it will be all round.

Chemistry, Metallurgy, And the High Cost of Living

THE complexity of modern life and the interdependence of science and industry make it difficult at times to segregate cause and effect or see their true relation. We cannot escape, however, the close connection among chemistry, metallurgy and the cost of our daily food, nor the responsibility that devolves upon representatives of those sciences in contributing to human welfare and happiness. President TONE did well, in his address as retiring president of the American Electrochemical Society, to direct attention to the human aspects of electrochemistry, for in the last analysis the success of that or any other industry lies in the degree to which it satisfies human desires or makes possible the wider enjoyment of the fruits of labor.

The situation may be illustrated with one or two instances that will make clear our obligation. Modern agriculture calls for more intensive cultivation of the land and a larger unit yield of crops. This means artificial fertilization and the substitution of mechanical for horse or man power. It means fixed nitrogen and tractors, available phosphate and rapid transportation, potash and electrical devices. It means chemistry, electrochemistry, metallurgy and electrometallurgy moving together hand in hand, ramifying throughout the entire agricultural industry. Upon the chemist and electrochemist devolves the duty of so perfecting the processes of making fertilizer that it will be cheap enough for widespread use. Upon the metallurgist and electrometallurgist must fall the burden of providing machinery makers with metals and alloys that are at once light, strong and inexpensive so that mechanical devices will become the farmer's common servants. With cheap fertilizer yielding increased crops at lower unit costs, and power appliances replacing the efforts of many men, food must appear in increased abundance and cost less to the consumer. Thus the cycle of achievement and service is completed, and the common good advanced.

A Resolution Of Forces

IT IS interesting to note how many of the after-war problems can be viewed as a resolution of forces, old forces being in play as well as many new ones. The steel industry is seeking an alignment, which will be the resultant of various forces. The ultimate value of the dollar will be the resultant of very many forces.

In the steel industry an ethical question has been presented: Who shall take responsibility for the overhead? The Redfield board, faced with some "cost sheets," decided that certain prices for finished steel, including rails, were fair. The Railroad Administration, presumably by having scrutinized reports of steel company earnings in 1918, regarded the prices submitted as altogether too high. Anticipating a period of relatively light demand for steel, the steel producers desired prices that would take care of their overhead, just as they did in 1908, while the Government is interested in seeing a maximum amount of labor engaged in productive occupation.

In the matter of steel prices there are forces pulling in diametrically opposite directions, and that is true not only of steel but of many other commodities. On the one hand there is a low purchasing power for the dollar, whereby it costs a great deal, measured in dollars, to produce steel. On the other hand there is a great mass of equipment in the United States, in bridges, buildings, factories, transportation systems and other things, which cost certain amounts to establish, measured in the old value of the dollar. If the value of these facilities is to be measured only by the same number of dollars as formerly, then there is little opportunity for the investor to create new facilities to compete with the old, as his investment will be so much greater. Hence he is indisposed to buy steel, and there is a force tending to bring down construction costs so as to make the competition feasible, in other words to increase the purchasing power of the dollar, while on the other hand there is a force tending to increase the nominal value of the facilities existing, whereby they will be valued by a larger number of the existing dollars than formerly. The situation is so plainly recognized that many corporations have only been awaiting a decision of the Supreme Court as to the taxability of stock dividends, in order to decide whether they shall issue such stock dividends, whereby the number of dollars to be represented by the plant investment would be increased, and with the same dividend rate a larger number of dollars would be distributed to the individual stockholder, each of which dollars would buy less, when the stockholder spends it, than before the war. The alternative, to pay much larger percentage dividends, is naturally not favored, as likely to arouse criticism on the part of those indisposed to admit that the lowering of the dollar's value is permanent, or who know nothing about such economic questions.

There must be an adjustment whereby the purchasing power of the dollar and its intrinsic value will be identical. Property values will increase to an extent, while commodities, labor, the ephemeral things that are bought, will decline. When harmony is established, or the forces are resolved, the adjustment will not be permanent. The experience after the Civil War is particularly instructive. An adjustment was reached, which lasted for several years, but there was extravagance, too much conversion of liquid into fixed capital for the permanent requirements of the country, and eventually a five years' industrial depression of great severity set up a new standard, which was too far in the opposite direction. There are quickly acting and slowly acting forces. Those who now think it will require a long time to readjust, to reconstruct the economics of things so that business will function, will be surprised at the shortness of the time, while those who feel that everything can be readjusted in short order will have their surprise later, when they find that the readjustment does not prove permanent, that slowly acting forces get in their work through a period of years.

Readers' Views and Comments

The Bradford Process of Preferential Flotation

To the Editor of Chemical & Metallurgical Engineering

SIR:—The recent article of Mr. Guy C. Riddell[1] on the Bradford process of preferential flotation prompts me to make a few remarks concerning the theory of his process. The facts are, as brought out in the article referred to, that sulphur dioxide does effect a wetting of the sphalerite without any apparent chemical action, since the mineral can be restored to its original condition by subsequent exposure to air or by agitation and aëration after the removal of the sulphur dioxide. It is also true that the effect of this agent is to remove the "gaseous envelope" from the sphalerite, but not from the galena and pyrite. The question of why the sphalerite only is affected has not, however, been answered, and this is the crucial point for any extensions of the process to other minerals or other addition agents. I shall present here a brief theory of this preferential action and indicate the possibilities of extending the process.

To begin with the "gaseous envelope" or adsorbed gas on most minerals with which we have to deal is air. In certain special cases it may be in part sulphur dioxide or hydrogen sulphide, but as the minerals have been generally exposed for considerable time to a gas atmosphere in which the partial pressures of all gases except oxygen and nitrogen are exceedingly small, it is reasonable to assume that these form the normal gaseous envelope. This envelope is the same on all minerals and there is no self-evident reason why sulphur dioxide or other addition agents should remove it from one more than from another. It is true, however, that sphalerite itself is much more soluble than galena or pyrite and hence will react with a bath containing a much lower concentration of acid. We may postulate, then, as the primary preferential reaction

$$ZnS + H_2SO_3 = ZnSO_3 + H_2S$$

or if the bath is acidified with sulphuric acid, the reaction

$$ZnS + H_2SO_4 = ZnSO_4 + H_2S$$

These reactions would not take place with galena or pyrite.

It can now be shown that hydrogen sulphide is adsorbed much more readily by sulphide minerals than is air. Some unpublished experiments of Bajoulian[2] show that galena, sphalerite and chalcocite through 80 mesh take up several times their volume of hydrogen sulphide in a few hours. The hydrogen sulphide liberated by the above given preferential reaction would then displace the adsorbed air and the net effect would be sphalerite with adsorbed hydrogen sulphide and galena and pyrite with adsorbed air. A secondary reaction would then take place by which the hydrogen sulphide would be removed from the sphalerite thus:

$$2H_2S + SO_2 = 2H_2O + 2S$$

The sphalerite would accordingly be maintained without a gaseous envelope and would be unamenable to flotation.

From this explanation it is obvious that a separation of any two sulphide minerals could be effected by using a bath sufficiently acidified to attack one and not the other, and then adding sulphur dioxide or other agent to remove the hydrogen sulphide envelope from the soluble mineral. Unfortunately the difference of solubility of the minerals is not great and they are mostly so insoluble as to require a prohibitive acid concentration.

It is difficult to arrive at any quantitative information regarding the concentration of acid necessary to attack any particular mineral, since the rate of attack is affected by the physical condition of the mineral as well as its solubility. The following table from Weigel[3] gives the solubility of several minerals in water:

Mineral	Mol/liter	Gram/liter
Galena, from Freiberg	1.21×10^{-6}	0.00029
Galena, artificial	1.21×10^{-6}	0.00029
Cuprous sulphide, regular	3.1×10^{-6}	0.00049
Sphalerite, artificial	6.63×10^{-6}	0.00065
Sphalerite, from Satander	6.65×10^{-6}	0.00065
Greenockite	8.99×10^{-6}	0.00130
Millerite	16.29×10^{-6}	0.00148
Wurtzite	28.32×10^{-6}	0.00281
Pyrite, artificial	40.84×10^{-6}	0.00490
Pyrite, from Freiberg	48.89×10^{-6}	0.00587

The accuracy of these figures is questionable, since they were obtained by conductivity measurements, and it is doubtful if the sulphides dissolve in water without hydrolysis. Certainly the position of pyrite is anomalous, as it is practically unattacked by dilute sulphuric acid, which quickly dissolves sphalerite.

It is possible that an electrochemical action may take place when several minerals are present; at any rate the electromotive series of the minerals seems to more nearly represent their solubility in dilute acid. This series is, according to Gottschalk and Buehler[4]:

Mineral	Volts Against Copper	Mineral	Volts Against Copper
Marcasite	+0.37	Metallic copper	0.0
Chalcopyrite	+0.30	Sphalerite	−0.2
Pyrite	+0.18	Stibnite	−0.2
Galena	+0.15		

According to this series the minerals lower in the table would exert a protective action toward those higher up. Thus in a mixture of pyrite, sphalerite and galena, the sphalerite alone would be dissolved and in fact at a much faster rate than in the absence of the other minerals.

For our purposes we may divide the minerals into two classes, those which give off hydrogen sulphide with dilute acid and those which do not. The following table gives these classes, the data being taken principally from Dana:

MINERALS ATTACKED BY DILUTE ACID		MINERALS NOT ATTACKED BY DILUTE ACID	
Sphalerite	Marcasite	Bismuthinite	Bornite
Greenockite	Zinkenite	Realgar	Chalcopyrite
Stibnite	Jamesonite	Orpiment	Pyrite
Pyrrhotite		Molybdenite	Cobatite
		Galena	Pyrargyrite
		Argentite	Tetrahedrite
		Chalcocite	Stannite
		Cinnabar	

The minerals which do not give hydrogen sulphide with acids include, of course, also minerals that are not sulphides, and no separation can be made among them by the Bradford process. The minerals which are soluble in dilute acid should, however, be easily separable from one or more of those not soluble. Separation

[1] CHEMICAL & METALLURGICAL ENGINEERING, Dec. 15, 1918.

[2] A thesis done under my direction at the University of Pittsburgh.

[3] *Zeit. Phys. Chem.*, 58, 293 (1907).

[4] Economic Geology, 7, 15 (1912).

among the soluble minerals could also be effected if the right concentration of acid were selected.

Some of the separations suggested as possible by this theory are pyrrhotite from chalcopyrite, pyrrhotite from gold, stibnite from galena, stibnite from sphalerite, sphalerite from greenockite, sphalerite from chalcopyrite, etc.

It is possible to conceive of various extensions to the Bradford process proper; for example, in a mixture of an insoluble sulphide and a mineral other than a sulphide, the two could be treated with hydrogen sulphide and the air on the sulphide mineral displaced, while if the treatment was not too long the air would remain on the other mineral. This mixture should then be separable by the Bradford process.

It should further be possible to replace the sulphur dioxide with any substance that would react rapidly with the hydrogen sulphide. This has been done in Minerals Separation patent 10478 (English), which calls for the use of chlorine or hypochlorites.

REGINALD S. DEAN.

American Zinc, Lead & Smelting Co.,
Research Department,
St. Louis, Mo.

Recovery of Potash

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the letter published in your issue of April 1 by Mr. N. H. Gellert in regard to potash recovery, in which Mr. Gellert contrasts the results set forth by Mr. Linn Bradley and myself in our respective articles published in CHEMICAL & METALLURGICAL ENGINEERING of Sept. 26, 1918, I may say that since that date other data have been assembled which show that some of the statements made then by Mr. Bradley and myself should be modified more or less in the light of later results. These modifications would primarily include, (1) cost of operating a Cottrell precipitator, and (2) loss of potash in the slag.

With reference to the cost of operating a Cottrell precipitator at a 200-ton iron blast-furnace, it may be stated that the figures covering operating cost published by Porter[1] for a 3000-bbl. cement plant would apply approximately for a 200-ton iron blast-furnace. Porter's figures, which are quoted in my article referred to by Mr. Gellert, are as follows:

Labor	$27.00	per day
Power	25.00	" "
Repairs	8.00	" "
Laboratory	4.00	" "
Total	$64.00	" "

Total cost per annum $23,360; but let us make it $25,000.

Porter also shows that operating on a mixture averaging about 1 per cent K_2O, on the basis of a selling price of $1 a unit (although present prices are much higher), the operating profit per annum would amount to about $65,300. It would, therefore, be interesting to know how Mr. Gellert gets at his operating cost of $42,000 per annum for a 200-ton blast-furnace. I cannot see that he would employ a larger and more expensive precipitator, more labor, more power, or require more extensive repairs than would be necessary for a precipitator capable of handling the dust of a 3000-bbl. portland cement plant, where the actual operating cost is less than $25,000 per annum. Deducting royalty, however, Mr. Gellert's figures may not appear to be about $17,000 too high, as they would otherwise, estimating, according to his figures, the cost of operating at $42,000; or, $45,000 too high when he estimates that it would amount to $70,000 per annum. It would, therefore, seem to be largely a question of how large a percentage of these figures is assigned to royalty.

In saying this I of course realize that the operating cost of $165,000 given in my article of Sept. 26, 1918, might appear absurdly high, unless it be remembered that these figures also included certain royalties, which were then but tentatively established. Then, too, at that time potash was selling on a $5 per unit basis. Also at that time no continually operating installation of a Cottrell precipitator had been made at any blast-furnace; and these figures were intended to be ultra-conservative, and were based upon investigations, rather uniform and rigid ideas as to royalties, etc., and work done by the Research Corporation. Nevertheless, the present writer at that time accepted these figures, but that he held certain mental reservations concerning them is evidenced by the fact that in the same article he pointed out under "Estimated Costs and Recoveries" the fact that where the materials treated have the same potash tenor, operating costs and recoveries for a 200-ton iron blast-furnace would approximate those of a 3000-bbl. cement plant.

But right here it should be stated that Mr. Gellert's discussion emphasizes—though he doesn't mention it directly—a most important point in regard to royalties in that, as different percentages of recovery would be had in case of variations of potash and other content of different ores, therefore a high and rigid royalty which might readily be paid in one case would not apply in another. This, however, has been recognized and suitable royalty adjustments to fit each particular case have now been made. Data assembled by the present writer since his previous article was written have demonstrated most conclusively the very point that Mr. Gellert brings out, namely, it is not correct to assume that the same percentage of slag "would be potash for different ores." The possibility of the recovery of potash from ores lean in potash is accordingly made much more attractive than but few persons six months ago would have been willing to admit that the data then available indicated. This thought, in which there is possibility of much fallacy and many absurdities, must not, however, be carried too far.

In my article of Sept. 26, Cambrian ores, red ores and brown ores are each treated separately, the idea being to show the yields and results to be anticipated if each ore be employed alone. As a matter of fact, blast-furnace practice in general is to mix either Cambrian gray ores with limey red or Clinton ores, or to mix brown ores with these limey Clinton ores. This general furnace practice is, of course, known to everyone familiar with furnace operation in the South; and hence final results should be sought upon a basis of the proper admixture of red ores with brown, or of red with the Cambrian gray. In this connection it would be interesting to know whether Mr. Gellert's figures are based on any of these admixtures.

Mr. Gellert brings out a point of very great interest when he calls attention to the fact that certain of the brown ores in the South run "about or close to 1½ per

[1] "The Recovery of Potash as a By-Product in the Manufacture of Portland Cement," by John J. Porter, vice-president and general manager of the Security Cement & Lime Co., Hagerstown, Md.

cent potash." If this statement can be shown to apply to any considerable number of important brown ore deposits, the potentialities that would thus be indicated would be very great indeed. It would also be both interesting and well worth while to ascertain the zinc content of these same brown ores.

The present writer regards Mr. Gellert's discussion of the articles referred to as having been most helpful. He finds that he differs from Mr. Gellert chiefly as regards the cost of operating a Cottrell precipitation installation; and although he considers that perhaps Mr. Gellert's figures are too high, at the same time he must himself acknowledge having similarly been in error in presenting without direct criticism the apparently excessively large operating cost to which Mr. Gellert alludes, which cost, though, since it included tentative royalties based on $5 potash, is not really as high as it might at first appear. Naturally, in the light of more recent experience and in the absence of this explanation, the cost referred to is justly open to criticism. Hence it would seem that perhaps both of us might be subject to criticism in the cases here cited for not having itemized our cost, as well as for treating royalties as a part of operating cost, as in the instance just mentioned. My belief is, therefore, that when all these facts are taken into proper consideration our results may really be quite closely in accord. For that reason it seems more advisable to follow Porter's plan as to this, because where different and undesignated royalties are included under operating cost, confusion is almost certain to result, as, for instance, in the case under consideration.

It should always be borne in mind that two royalties are to be included, one for gas cleaning alone and another for valuable products collected. In certain instances the latter may amount to little or nothing, but the service for gas cleaning is always highly valuable. Obviously, though, the royalty for gas cleaning should not be charged against the recovery of valuable by-products, but rather against the cost of furnace operation, since the Cottrell processes make for greatly increased efficiency and economy in furnace operation regardless of the recovery or non-recovery of valuable by-products.

In conclusion, I should say that one of the things which has prevented installation of Cottrell processes at iron blast-furnaces is the widespread impression that the cost of precipitators is very high. According to the Research Corporation, the approximate cost of a precipitator is $1 per cu.ft. of gas treated, making the cost of installation at a 200-ton blast-furnace about $50,000. If electrical equipment be included, the cost of a 2-unit precipitator for a 200-ton blast-furnace would, according to the Research Corporation, "be in the neighborhood of $55,000 to $60,000." We find, however, that by using materials equally as suitable, though less expensive than those called for in the specifications issued by the Research Corporation, the initial cost of a Cottrell installation may be very materially reduced.

On this subject, just as soon as the opportunity is afforded, the present writer will be able to present certain data of a detailed nature which should prove quite helpful to those who plan to make Cottrell installations.

J. S. GRASTY.

Charlottesville, Va.

Heat Treating of Shells

To the Editor of Chemical & Metallurgical Engineering

SIR: The paper by Mr. J. M. Hall read before the Steel Treating Research Society at Detroit on heat treatment of shells, reviewed in your Feb. 15, 1919, issue, is a surprise as to its longevity.

The method of treatment should have been challenged in the meeting at the time of the birth of this paper. The treatment could not possibly be applied to 155-mm. high-explosive shell and have a ghost of a chance to pass the physical requirements of the U. S. Ordnance Department, and it is a blessing in disguise it was not widely published in this country, leading American shell manufacturers into trouble by adopting such procedure.

The method is not only extremely crude, but is misleading as well. Heat treating conducted as indicated in the paper permitting a range of temperature for quenching of 200 deg. F. (from 1500 to 1700 F.) and a range of 400 deg. F. (from 950 to 1350 F.) for drawing, on steels having a carbon range of only 0.15 per cent and a manganese range of 0.4 per cent is something unheard of here. It surprises me that even the very liberal British specifications would permit such practice.

Such treatment as that quoted—annealing 60 per cent carbon steel at 1600 deg. F. to reduce the ultimate tensile strength 7000 lb. and increase elongation 6 per cent—is absolutely unreliable and indicates vague knowledge of the condition of the treated steel. The same holds true for the practice of raising the ultimate tensile strength by air cooling from 1550 to 800 deg. F. in 7 minutes. The proper treatment of the steel would have given the desired properties.

Twin City Forge & Foundry Co., Stillwater, Minn. W. J. MERTEN.

Large vs. Small Electric Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was much interested in reading Mr. Bardwell's communication in the Dec. 1 issue of this journal on relative efficiencies of various sized electric furnaces, but my experiences do not agree altogether with those published by him. I have in mind two plants, operating 3-phase electric shaft furnaces on the same kind of alloy, one of about 2000-kw. capacity and the other consuming approximately double that amount of energy at a voltage but slightly higher. The average power consumption on the large unit was but 7 per cent less than that of the smaller unit per gross ton of metal produced.

Of course the big problem in the manufacture of ferro-alloys is the reduction of the volatilization losses. Even though the cost of ingredients may not compare with the cost of manganese ore, nevertheless a general reduction in volatilization losses means a corresponding reduction in power input, resulting in a decrease in production cost. However, there are minor problems that are common to most furnace operations and affect the final cost of production in varying degrees. One of these is the reduction of electrode consumption. I wish that Mr. Bardwell had given some data on the variation of electrode consumption with variation of voltage. It is my prediction that with higher voltages, at least up to a certain limit, there will be a decrease in the amount of electrodes used per ton of material produced. R. E. BAKER.

Keokuk, Iowa.

Western Chemical and Metallurgical Field

Working Conditions in the Zinc Smelters of the Gas Belt

HASTILY gathered statistics of zinc smelters in the gas belt (Kansas, Oklahoma and Arkansas) show a present gross retort capacity of about two-thirds the maximum number capable of operation at the peak of war production. Table I gives the figures, the capacity in 1917 being taken from a table published in the *Engineering and Mining Journal*, Vol. 107, p. 58, while the figures for 1919 are approximately correct, an asterisk marking the doubtful entries. The difference between the first and second columns really represents the number of retorts abandoned from a failure of natural gas supplies, while the difference between the second and third columns represents the stagnation in the present zinc market. Hardly one-half of the available retorts are now running, this figure amounting to approximately one-third the number during the war.

Practically all of the operators have been struggling against the inevitable for the last 18 months. During this time the zinc market has been perilously near the cost of production, if not actually below it, with the result that even the most favorably placed works have gradually curtailed. In this period only one plant has added to its capacity, namely, the Athletic Mining & Smelting Co., at Ft. Smith, Ark. The reason why this is true is apparent. Before the war 5c. was considered a fair price for zinc—when it dropped to 4.5c. many of the smelters drew their fires. Taking the reasonable figure of 60 per cent as the increased cost of manufacturing during the last year, the danger point corresponding to 4.5c. is now 7.2c., a figure below which the metal has been for some time.

Smeltermen in the gas belt have shared in the general increase in war-time wages. No general wage scale holds for this region—rates at neighboring plants in the same town may vary as much as 3c. per hour. Thus during 1917, first chargers received anywhere from $3.75 to $5.25 per day, while common labor ranged from $2 to $3. However, in the Tulsa region no less than six increases in wages were posted since May, 1914, increasing that of common labor from $1.75 for 12 hr. to $3.45 for 8 hr., the change in shift being made in July, 1917. Unfortunately these were mostly "flat increases" rather than percentage raises; the result was the reduction of the differential betwen jobs to such a point as to remove the incentive for a workman to take the harder, better or dustier jobs.

Notices of reduction in wages were posted in practically all plants on April 1, ranging from 10 to 15 per cent, in many instances so designed to establish the old differentials between skilled workmen and laborers. Dividing the number of men on a block by their aggregate daily wage, the following rates hold at a representative plant:

Average rate in 1914	$2.285
Rate in January, 1919	4.180
Posted rate April, 1919	3.626

The latter rate is 55 per cent higher than before the war, and represents about the same purchasing power. However, the workday is now universally 8 hours.

Smeltermen at all the unionized plants working under agreements accepted the decrease under protest, and these plants continue, pending an appeal to the national headquarters of the union. However, workmen at the Bartlesville Zinc Co.'s two plants in Bartlesville and at the United States Zinc Co. in Sand Springs have struck, and these plants are now under dead fire. Union organizers are busy and the problem of recognition of the new unions will probably loom larger than wage scales.

TABLE I—ZINC SMELTING CAPACITY IN GAS BELT

Company	Location	Capacity 1917	Capacity 1919	Running March, 1919
American Zinc, Lead & Smelting Co.	Dearing, Kans.	4,480	Dismantled	.....
American Zinc, Lead & Smelting Co.	Caney, Kans.	6,080	6,080	.....
American Zinc, Lead & Smelting Co.	Neodesha, Kans.	3,760	3,760*	.....
Arkansas Zinc & Smelting Corp.	Van Buren, Ark.	3,200	3,200	2,400*
Athletic Mining & Smelting Co.	Ft. Smith, Ark.	1,664	2,400	2,400
Bartlesville Zinc Co.	Bartlesville, Okla.	8,640	8,640	4,608s
Bartlesville Zinc Co.	Blackwell, Okla.	9,600	9,600	4,800
Bartlesville Zinc Co.	Collinsville, Okla.	13,440	Dismantled	.....
Chanute Spelter Co.	Chanute, Kans.	1,280	Dismantled	.....
Eagle-Picher Lead Co.	Henryetta, Okla.	3,000	3,000	3,000
Edgar Zinc Co.	Cherryvale, Kans.	5,040	5,040	4,536
Ft. Smith Spelter Co.	Ft. Smith, Ark.	2,560	2,560	2,560*
Henryetta Spelter Co.	Henryetta, Okla.	3,000	?	?
Iola Zinc Co.	Concreto, Kans.	660	Dismantled	.....
Joplin Ore & Spelter Co.	Pittsburgh, Kans.	1,792	Dismantled	.....
J. B. Kirk Gas & Acid Co.	Iola, Kans.	3,440	3,440*	.....
Kusa Spelter Co.	Kusa, Okla.	9,120	9,120	3,050
Lanyon Smelting Co.	Pittsburgh, Kans.	448	448	.....
National Zinc Co.	Bartlesville, Okla.	4,256	4,256	3,648
Pittsburgh Zinc Co.	Pittsburgh, Kans.	910	910	.....
Prime Western Spelter Co.	Gas City, Kans.	4,866	Dismantled	.....
Quinton Spelter Co.	Quinton, Okla.	2,016	2,016	1,008*
Tulsa Fuel & Manufacturing Co.	Collinsville, Okla.	6,232	6,232	2,816
United States Smelting Co.	Altoona, Kans.	4,640	Dismantled	.....
United States Smelting Co.	Checotah, Okla.	5,120	5,120	.....
United States Smelting Co.	La Harpe, Kans.	1,926	Dismantled	.....
United States Zinc Co.	Henryetta, Okla.	2,400	2,400	2,400
United States Zinc Co.	Sand Springs, Okla.	8,000	8,000	3,200s
Weir Smelting Co.	Caney, Kans.	1,920	1,920	1,920
Weir Smelting Co.	Weir, Kans.	448	Dismantled	.....
Totals		123,938	88,142	42,346

Surplus Government Supplies

Copper.—The United Metal Selling Co., representing the copper producers, will sell for the War Department approximately 100,000,000 lb. of copper, at the rate of not less than 5,000,000 lb. per month for a period of ten months and 10,000,000 lb. per month for the next five months. The copper will be sold at market prices, as determined by the average quotations in the *Engineering and Mining Journal*.

Caustic Soda and Soda Ash.—As the surplus of soda ash is only 2,500 tons, this will be sold through the various selling bureaus at current market prices. The amount is so small in comparison with normal consumption that no effect on the trade is anticipated. The surplus caustic soda, 4,000 tons, will probably be disposed of through the manufacturers, so that none will be placed on the market by any of the agencies of the War Department.

Proposed Pan-American Commercial Conference

The Governing Board of the Pan-American Union has voted to hold, under the auspices of the Union, an informal Pan-American Commercial Conference during the last week of May or the first week of June, 1919, in Washington, D. C. It is expected that about 1000 delegates will attend and that the sessions will be addressed by the President, members of his Cabinet, Latin-American Ambassadors and heads of various Government boards and commissions. A complete record of the Conference will be published by the Pan-American Union as a useful handbook of Pan-American trade. The success of a similar conference in 1911 is assurance that the contemplated conference will be a marked success.

JOSEPH ESREY JOHNSON, JR.

An appreciation

By Bradley Stoughton

MR. JOSEPH ESREY JOHNSON, JR., had already gained rare distinction as an able metallurgist, clear thinker, brilliant author and wise consulting engineer to bankers and operators and had achieved the essentials of a great career when death cut short his activities on April 4, 1919, in the forty-ninth year of his age. He belonged to a family of iron blast-furnace men and mine managers. His father, Major J. E. Johnson, after serving with distinction in the Army of the North, identified himself with the iron mines and blast-furnace at Longdale, Va., with which he was connected during almost his entire business life. It is significant that during those troublous times of reconstruction in the South, he enjoyed always the affection and respect of his neighbors and associates alike. From him his son obtained not only a thorough training in blast-furnace practice and iron mining, but great personal courage and force of character. His mother, who survives both her husband and sons, possesses rare intellectuality, humor, and a tenderness and human sympathy which those who were privileged to know well J. E. Johnson, Jr., recognized beneath his exterior of aggressiveness and will power.

JOSEPH ESREY JOHNSON, JR.

In a recently published analysis of the qualities which characterize the world's great men, three traits stand out preëminent, viz., independence, courage and intellectuality. Each of these characteristics J. E. Johnson, Jr., possessed in extraordinary degree. His early education was obtained under a private tutor at Longdale, and this circumstance probably enhanced a natural tendency to independence of character and individuality which, however, under the control of his unusual power of straight thinking and clear analysis never allowed him to go far astray. It has been said of him that if once he set his mind to a problem, however knotty, he scored a bullseye before the subject was dropped.

His manner of attacking a subject involved first mastering the details of the present available knowledge; then putting this acquired information to one side with an untrammeled mind, blazing out a path of his own, so clear, so well-defined, and expressed in such simple terms that he illuminated the whole subject without distorting the original data or discussion. His two books on the iron blast-furnace together form the most comprehensive, the most enlightening, and the most useful treatise on the subject ever produced in any language.

But his ability did not end with the mastery and elucidation of principles enunciated by his predecessors. His own discoveries and inventions in the metallurgy of iron have established his reputation in every civilized country where iron and steel are made. The three most important of these, doubtless, are his thermal theory of the iron blast-furnace, which ranks with Sir Lowthian Bell's chemical practice of the iron blast-furnace as one of the two greatest scientific advances in our knowledge of the art; his original classification of iron and steel as an unbroken series of alloys of iron and carbon; and his discovery that oxide, instead of being the unmixed evil which it was accredited in the minds of most metallurgists, actually benefited the strength of cast iron.

There are many stories told of Esrey Johnson's personal courage, but probably the most spectacular one is the prevention of an attempted lynching in Virginia in 1909. A young white girl had been murdered by a colored boy under those horrifying circumstances with accounts of which we are all too familiar. Johnson was not only manager of the mines and blast-furnace of the locality, but was one of the officials of the county. He organized the search whereby the negro was captured, brought to Johnson's office and a confession of the crime wrung from him. The usual crowd collected quickly, thirsting for vengeance in the form of hanging or burning. Practically alone, Johnson held this crowd at bay for several hours, sometimes mixing with the crowd and pledging his honor that the colored boy should be tried and executed according to law, sometimes pleading for the good name of the community, and when necessary, "showing his teeth" to those who can understand no other argument for the curbing of their personal inclinations or intentions. He has told me that he expressed himself in substantially these words: "I am going to see this nigger hung in accordance with law and order. If you fellows try to prevent me, you may get me, but I will get some of you first." I am sure that at this point in the argument he smiled, for he had a very expressive smile which endeared his friends to him, and which he could make very convincing when he desired. Finally, the morning train arrived on the track just outside Johnson's office. He realized that this was the moment when a coup would be attempted, but he had already laid his plans with the sheriff over the long distance telephone. The train stopped exactly where he had directed. He rushed the trembling culprit by the crowd of angry, heavily-armed men into an empty railroad car occupied only by the sheriff. The door was barricaded behind the three men and the train pulled out before a rush could be accomplished. Another crowd had to be overawed at the entrance of the county courthouse where the judge had called a special term of the court. To him Johnson delivered his prisoner and made good on his promise that justice should be done, which it ultimately was. The story of this interesting episode is told in the *American Law Review* for November-December, 1911, under the title "Lynching Unnecessary."

Johnson led a white life. There was no weak spot in his professional or personal armor of honor and sincerity. His home life was an unusually happy and congenial one. He married Miss Margaret C. Hilles of Wilmington, Delaware, and she was not only his friend and comrade, but an intellectual stimulus and helpmate in a very busy life. She, with one boy, J. E. Johnson, 4th, survives him.

I cannot give a better summary of Johnson's professional attainments than by quoting from a letter from his friend James Gayley. These two master minds found mutual sympathy and understanding. Johnson had an unbounded admiration for Gayley, whom he describes in the dedication of his books as the "founder of modern American blast-furnace practice." Gayley made of Johnson a pupil and gave him valuable advice and assistance during the early days of his establishment as a consulting engineer in New York City. On the day of Johnson's death, Gayley wrote to me as follows:

"American metallurgy of iron has lost its shining light and the world is poorer thereby. . . . Esrey Johnson is and was the greatest man in the metallurgy of iron and the clearest thinker of any man today. He seems like a younger brother gone and none come to fill his place."

Johnson always identified himself with the public work of his profession and community. He was for many years a member of the principal engineering societies, being active in the American Society of Mechanical Engineers, the Mining and Metallurgical Society of America, and the American Institute of Mining and Metallurgical Engineers. His pen has enriched the literature of these and other societies on both sides of the Atlantic. His interests naturally brought him more closely into affiliation with the A. I. M. E., for which he served as a member of the board of directors and chairman and member of many prominent committees, including the vice-chairmanship of the iron and steel committee. Of recent years he had been active in guiding the policies of this Institute, and at the time of his death was, besides a director, a member of the executive committee and chairman of the committee on admissions.

The Engineer as a Citizen

ON Wednesday evening, March 26, the New York Sections of the American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and Society of Automotive Engineers held a meeting at which was presented an engineers' symposium on "The Engineer as a Citizen." Local members of the electrical engineers, civil engineers and thirteen other engineering and technical societies were invited to participate.

In opening the meeting the presiding officer, MR. GANO DUNN, called attention to the fact that engineers were earnestly examining themselves and their organizations to determine what their relation should be to society. He felt that we should not be led astray into a zeal for doing things for society in general which we would not do first for our fellow engineers, and that the man is inconsistent who urges something for society which he is unwilling to do for his fellow engineer.

CIVIC RESPONSIBILITY OF THE ENGINEER

The first speaker was MR. PHILIP N. MOORE, representing the American Institute of Mining and Metallurgical Engineers, who spoke on the civic responsibility of the engineer. Mr. Moore saw the engineer waking from a long sleep of indifference to a sudden realization of the fact that he was not politically potent. Examining the reasons for this failure of the engineer to count as a class politically, Mr. Moore found the following reasons: First, a lack of local attachment. Engineers are constantly working themselves out of a job and have little time or inclination to take an interest in local affairs. Being without local responsibilities they have a small sense of civic duty. Again the relation of the large proportion of our engineers to the great business consolidations, many of which have in the past been antagonistic to the interests of society, leads them to withhold from civic activities. Furthermore, the training of the engineer is too often merely technical and fails to give him an interest in the welfare of the community of which he is a part. The remedy for the isolation of the engineer lies within himself, and he must realize that it is his duty as well as his privilege to participate in civic affairs. Mr. Moore felt that the engineer's voice would be a potent factor in bringing the world to a realization of some elemental truths, namely, that the hand deserves not the same reward as the brain; that there is no justice in the demand of the worker to share profits unless he is also willing to share losses, and that there is no partnership where gains alone and not risks are shared; that no wages are earned which are not fully reproduced in product; that labor can be paid only from the product of its toil when that product is sold at a profit; that all products are the result of the joint effort of labor, capital and management, and that all of these must share the output.

RELATION OF THE ENGINEER TO LEGISLATION

MR. CALVERT TOWNLEY, representing the American Institute of Electrical Engineers, spoke on the relation of the engineer to legislation. He reviewed briefly the efforts which engineering societies had made in recent years to influence or bring about legislation on engineering matters and showed that the policy generally had been to confine the activities of engineers to a statement of the facts and to refrain from expressing views as to the wording of any legislation or opinions on legal matters. The speaker was of the opinion that this is about as far as engineers can go because, while they will be found in close accord on fundamental engineering questions, they cannot be expected to agree on general legislation any more than any other body of educated men. He spoke of the efforts of Engineering Council to keep in touch with legislation through the National Service Committee with an office in Washington, D. C. In conclusion it was the speaker's opinion that we should not try to influence legislation which concerns us only as citizens, but that if we undertake the task at all we should concentrate on certain specific lines of engineering importance.

The relation of the engineer to administration was discussed by MR. NELSON P. LEWIS, representing the American Society of Civil Engineers. The speaker found that engineers were assuming a more important

place in the administration of large industrial enterprises, but that they have been more completely excluded from the public administration of the affairs of cities and States. Mr. Lewis asked, however, "What is the city or State but a public service corporation?" He felt that engineers should play a conspicuous part in the administration of city and State affairs. He showed how the commission government plan grew out of the Galveston disaster, and the commission-manager plan out of Dayton's experience in 1913. He felt that the engineer with executive capacity was especially well qualified to fill the position of commission-manager in city administration. At the beginning of 1919, 124 cities and towns in the United States were operating under some form of the city-manager plan, and out of 88 of these managers 50 were professional engineers, 9 merchants, 6 minor city officials, 5 general business, 3 superintendents of construction, 2 journalists and 13 miscellaneous. In conclusion the speaker felt that the trained engineer is the logical man to manage undertakings involving the planning and execution of engineering work, and that the educational preparation for such work should include a knowledge of business and administrative methods as well as a knowledge of purely technical subjects.

The Engineer and Public Opinion

Mr. Spencer Miller, representing the American Society of Mechanical Engineers, spoke on the relation of the engineer to public opinion. The speaker believed that "public opinion is not always right, but it is always autocratic." He felt that the importance of the engineer in public life was such that we should make every effort individually and collectively to mold public opinion in the right direction and especially to counteract the propaganda which tends to stir up class hatred. Many of the engineers who occupied positions of responsibility during the war will be invited to accept still larger responsibilities as public servants, and they have an opportunity to mold public opinion along the lines of honesty, integrity, unselfishness, self-control and co-operation. These qualities make the engineer successful in public life. The speaker was of the opinion that a Congress half lawyer and half engineer would be superior to one all lawyer or all engineer. Both types are needed in public and political life. The speaker felt that a good beginning toward molding public opinion would be the adoption of a code of ethics which should become the moral foundation of all engineering associations.

Production and Distribution

Dr. C. A. Adams, president of the American Institute of Electrical Engineers, closed the symposium with a discussion of the relation of the engineer to production and distribution. He departed from his subject in the beginning to say that his long experience with engineering education had convinced him that it is not the curriculum and the subjects taught that count in the making of an engineer, but that the way in which they are taught is the important matter. He believed that one could "put more spirit and more character building and more general preparation for citizenship into a course in dynamo design" than could ordinarily be found in courses in economics, history or government. The speaker then referred to the industrial situation in the world today and the part which the engineer could play in effecting a settlement between contending forces. The machinery of production and distribution is largely in engineers' hands and he thought that it could be so improved as to increase the productivity of labor and thus make possible a living wage and a fair return for capital. He felt that our present competitive methods are wasteful in the extreme, and add to the cost of production and distribution.

There was considerable discussion of the subject, with particular reference to ways in which the engineer could function in public affairs through his societies. Mr. S. N. Castle suggested that there were four methods: The merger of existing societies into one large national organization; a New York engineering society or metropolitan association of engineers to comprise the New York sections of the national societies; an association of the delegates or officers of the New York sections of the national societies; or finally, interlocking committees in the national societies. Mr. Daniel Turner felt that there was no need of organizing a new society, but that the American Association of Engineers could serve the purpose of uniting all engineers in matters relating to public affairs. Mr. J. E. Johnson, Jr., thought that Engineering Council could serve engineers better if it were more national in its scope. It was his opinion that this organization was suffering from distinguished men who had made their reputations and who hesitated to take any serious or radical steps for fear of losing what they had gained.

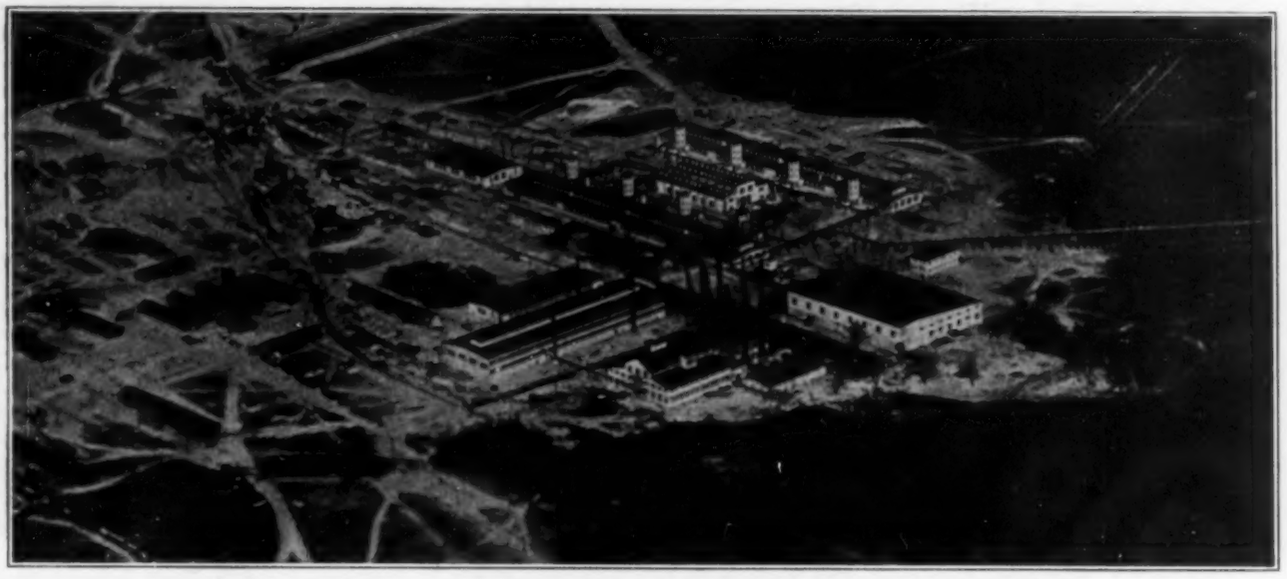
Joint Conference for Closer Co-operation

A resolution was adopted asking the various societies represented, or their local sections, to appoint delegates to attend a joint conference with a view to organizing for closer co-operation between engineers in the metropolitan district. Another resolution called upon all engineering societies of this country which have not yet appointed committees on development, to appoint such committees with instructions to undertake a survey of the aims and purposes of their respective organizations and to co-operate with similar committees of engineering societies. A third resolution called for the appointment of delegates from the societies repesented in the meeting to a conference for the purpose of discussing and formulating a proposed code of ethics for the professional conduct of engineers.

Manufacture of Phthalic Anhydride

On June 16, 1917, the Department of Agriculture announced that the Color Laboratory of the Bureau of Chemistry had developed, on a laboratory scale, a new process for the manufacture of phthalic anhydride and was ready to co-operate with manufacturers in the attempt to develop the process on a commercial scale. All of the co-operation that could be handled at that time was obtained and on Nov. 1, 1917, the offer of co-operation was withdrawn.

Inasmuch as a number of manufacturers recently have expressed a desire to produce phthalic anhydride and co-operate in the experimental work, the Department of Agriculture announces that it is ready to assist manufacturers by reopening this offer of co-operation on the same terms and under the same form of agreement as originally made with other manufacturers. This offer of additional co-operation is made possible by the release from war work of men of the Color Laboratory. It will not be held open indefinitely.



AEROPLANE VIEW ELECTROLYTIC CHLORINE PLANT, EDGEWOOD ARSENAL

New York Meeting of the American Electrochemical Society

First Post-War Meeting Marked by Symposium on Released Information Showing Part Played by Electrochemistry in the War—Election of Officers and Transaction of General Business—Excellent Financial Condition of the Society

THE thirty-fifth general meeting of the American Electrochemical Society convened at the Chemists' Club in New York City, April 3, 4 and 5. Being the first post-war meeting of the Society, there was a large attendance and ample evidence of removal of that sober restraint which the business of war had exercised over the activities of the members. Thus Section Q and its familiar pastimes were revived at a smoker with the usual success; and a trip of inspection scheduled for Saturday morning was well attended in spite of inclement weather.

MEETING OF THE DIRECTORS

The Directors met for the transaction of annual business and considered some important matters. The sum of $2000 was set aside for investment in the forthcoming Victory Loan, following the precedent established for previous Liberty Loans. This will make a total of $10,000 invested in Government bonds. The general financial condition was shown to be unusually good. Liquid assets aggregate $20,000, or $10 per member. Additional assets in the form of publications, which are being sold at the rate of about $2000 per annum, amount to another $20,000, or a total of about $20 per member. The membership committee reported a membership of 1928.

At the invitation of Engineering Council the directors appointed MR. F. A. LIDBURY to represent the Electrochemical Society at a meeting of the National Service Committee of the Council, to be held in Chicago April 23-25, for the purpose of promoting the establishment of a Department of Public Works in the Federal Government. Mr. Lidbury was instructed to support the movement.

A committee, not yet named, is to be appointed to co-operate with the American Society for Testing Materials on standard lime specifications.

MESSRS. COTTRELL and DWIGHT were appointed to represent the Society at a conference in Paris called to consider an inter-Allied federation of industrial chemical societies.

A resolution was adopted approving proposed legislation by the next Congress appropriating $50,000 for a water-power survey of the country by the Geological Survey, and $200,000 for a survey by the Geological Survey and the Bureau of Mines of the various sources of power in the industrial region of the North Atlantic seaboard.

OFFICERS ELECTED AT ANNUAL BUSINESS MEETING

The committee on patent legislation was represented by MR. E. J. PRINDLE, who presented a digest of the report prepared by the patent committee of National Research Council, with the recommendation that the Electrochemical Society approve it. This report has already been published in CHEMICAL & METALLURGICAL ENGINEERING, Feb. 15. It was approved by the Society.

The recent annual election of officers for 1919-20 resulted as follows: President, Wilder D. Bancroft; vice-presidents, J. V. N. Dorr, W. R. Whitney, Carl Hering; managers, H. C. Parmelee, R. E. Zimmerman, E. Blough; treasurer, P. G. Salom; secretary, J. W. Richards.

OPPOSE GOVERNMENT OWNERSHIP AND OPERATION OF WATER POWERS

The Committee on Public Relations presented a report condemning Government ownership and operation of water powers. This report met with some opposition

on account of its partisan nature, the opponents of its adoption not necessarily opposing its provisions, but feeling that it would have even more force if it was more judicial in tone and not a bit of special pleading. In spite of opposition, however, the report was adopted as follows:

"It is understood that this report does not consider the question of the Government ownership of sources of hydro-electric energy nor of Government control and regulation of hydro-electric systems; but simply operation by the Government of hydro-electric systems in comparison with operation thereof by private companies. As regards this aspect of Government ownership it is the opinion of your committee:

1. That anything which affects, either for good or evil, electrochemical industries will effect in a corresponding way the people as a whole.
2. That the inherent defects of governmental activities in industrial enterprises will be found in Government ownership of hydro-electric systems and will affect the electrochemical industries dependent on such systems adversely.
3. That the American Electrochemical Society, being interested in and representing the electrochemical industries of the United States, should strongly oppose all attempts at governmental operation of hydro-electric systems.

"It is needless to present any evidence to the members of the American Electrochemical Society that the electrochemical industries are of vast importance to the whole nation and to every individual composing it.

Even a superficial examination of numerous governmental activities shows that those which can only be undertaken by the Government leave much to be desired in their results and that when these are of an industrial nature they are invariably inefficient, uneconomical and subject to numerous glaring defects which are obviously inherent in governmental work of this kind in a democracy, when the present state of human character is considered. Under an autocratic government certain causes of the defects of such governmental activities do not exist; but, as recent experience has shown, even when the existence of a democratic nation is threatened by external aggression and a temporary reversion to autocratic government becomes necessary, governmental industrial enterprise is far inferior to private undertakings of this nature.

"It is the belief of all American citizens that governments are instituted among men to secure certain inalienable rights, among which not the least is individual liberty, and that the reason why their country has prospered so wonderfully is because those intrusted with its administration have not only confined themselves within their constitutional spheres, but have refrained from encroaching on and consequently diminishing the fields of activity of its citizens. Most of our citizens who have given the matter careful thought also believe that governmental encroachment in such fields will greatly overbalance, in permanent evil, any partial or transient benefit which it may yield.

"There is no evidence that governmental ownership of hydro-electric systems will be any freer from defects than other kinds of governmental industrial enterprise, but quite the contrary.

"Your committee believes that the American Electrochemical Society should have an opportunity to go on record as opposed to Government ownership and operation of hydro-electric systems and that this record should be given the widest publicity."

The Smoker and Inspection Trip

The smoker, under the direction of Mr. M. B. Coho, proved to be a great success. As a parody on the afternoon's program on released information, Mr. Ellwood Hendrick read a paper on Deceased Information, in which he brought forward a few delicious bits of scientific information promulgated by Pliny the Elder, who perished in the eruption of Vesuvius, 79 A.D. This was followed by an exhibit of unusual views of some members of the Society, thrown on the screen and "explained" by Mr. L. E. Saunders. The program was concluded by a view of several animated mechanical movies, by courtesy of the Bray Studios. These included demonstration of the mechanism and operation of the Lewis machine gun, the internal combustion engine and the telephone. Singing and a Dutch lunch concluded the plans for the evening.

The inspection trip Saturday morning was attended by over 100. Visits were made to the Loose-Wiles Co., the Wright-Martin Aircraft Co., and the Nichols Copper Co. Luncheon was served at the latter place by courtesy of the company.

Presidential Address and Technical Papers

The opening address was that of President Tone on "Electrochemistry in Its Human Relations," which is printed in full elsewhere in this issue.

Principles of Inductive Heating With High Frequency Currents

DR. E. F. NORTHRUP, who has recently perfected a new type of electrodeless electric furnace at the Palmer Physical Laboratory at Princeton for the Ajax Metal Co., gave the theoretical principles involved in inductive heating. He derived equations whereby rates of heating and thermal efficiencies can be obtained in quaternary circuits with e.m.f. impressed on the primary circuit, also general equations applied to a single pair of coupled circuits. In conclusion Dr. Northrup said:

"The development of electric heating with high-frequency currents and without interlinkage of an iron magnetic circuit with an electric circuit was brought by the writer to its present stage of development (December, 1918) almost entirely by laboratory experimentation. In the course of this experimental work it has been proved beyond doubt that, using oscillatory currents to secure the requisite frequency, rapid heating of a crucible and its contents may be obtained with a thermal efficiency in the neighborhood of 60 per cent, and temperatures up to 1800 deg. C. or 2000 deg. C. may be obtained. Batches of several kilograms of such materials as Pyrex glass among the non-conductors and pure iron and pure nickel among the conductors have been rapidly melted in air and in vacuum. Platinum has recently been melted without the presence of carbon in a 20-kw. furnace sold to the Baker Platinum Co.

NATURE OF PROBLEMS RECOGNIZED

"After these experimental results had shown the correctness of the physical ideas which led to and guided the experimental developments, the precise nature of the problems involved became more and more clearly recognized. The necessity became apparent for developing in a comprehensive way a complete theory of this method of electric heating, and of other entirely new engineering matters which develop when high-frequency currents, in connection with large amounts of power, are utilized.

"These theoretical foundations have now been laid and all the basic mathematical relations have been found which are necessary for, and will permit the design of, very large power heating units.

"For electric furnaces which require the use of 100, 500, 1000 kw. or more, it is highly probable that the best and most practical source of the high-frequency current required is, in the light of present practice, an electric generator direct connected to a steam turbine.

VOLTAGES REQUIRED

"Practical considerations demand that the voltages applied to, and used near, the heater unit shall be well below any voltage which might be dangerous to life. The mathematical treatment proves that there is no theoretical limitation in this method of heating, either to the voltages which may be safely used or to the size of the units and the amount of power which may be employed. Theory also shows that in all cases where the high-frequency current is obtained from an alternator the supply lines can furnish power at practically unity power factor and that the possibilities of obtaining high thermal efficiencies and rapid heating and elevated temperatures are equal to or better than the results obtained in these respects by standard methods of electric heating. Futhermore, both theory and experiments have proved that uniformity in the temperature of the heated mass, perfection in the control of temperature and the ability to heat up charges from the cold with great rapidity exceed anything heretofore obtained in electric furnace practice.

PATH NOW LAID FOR ADVANCE

"The path is now laid and the mathematical formulæ are given for the purely engineering advance in the designing of large power units for heat treatment of materials (glass, non-ferrous and ferrous metals) in tonnage quantities.

"The oscillatory current system for obtaining the required current of high frequency has not so far been utilized in power units exceeding 60 kw. The large expense of the condensers required, which are only active in the oscillatory current method from one-fifth to one-sixth of the time, the rather low power factor connected with this system and the high voltages required for generating the oscillations would seem to limit this method of obtaining high-frequency current to single power units of the order of magnitude of 100 kw.

"Two or more oscillatory current systems may be made, however, to operate in conjunction to heat a single furnace of large dimensions.

"Because, on the other hand, high-frequency currents may be obtained with oscillatory discharge with ap-

paratus which contains no moving parts and which has an exceedingly slow depreciation, this system of heating is ideally adapted to small power installations and to all kinds of laboratory furnace practice.

Larger Problem Awaits Solution

"The much larger problem, of the heat treatment of materials in tonnage lots, awaits for its practical solution the development of less expensive and more efficient means of obtaining currents of 10,000 cycles or more in limitless amounts. Intensive investigation is now in progress in several quarters looking to the development of high-power, high-frequency apparatus, and full success in this matter will mean a great and highly satisfactory solution of the future commercial heat treatment of materials in large quantity by means of the electric furnace."

Extraction of Uranium From Pitchblende

The carbide method of separation as developed by Gustave Gin and communicated to the society prior to his death was given in connection with the methods used at Joachimsthal.

The powdered mineral is roasted in a reverberatory furnace until sulphur is all removed. Almost all the arsenic is likewise removed and the uranium changed into sesquioxide.

The roasted material is mixed with carbon and put into an electric furnace with two hearths. The quantity of carbon introduced should be insufficient to reduce all the metallic oxides. The lead, copper, iron, nickel, cobalt, and perhaps a little of the tungsten, will be liberated as metals, and there is formed a slag containing silica and the lower oxides of uranium, vanadium, tungsten and molybdenum. The base metals are run off and carbon is then added to the slag in sufficient quantity to reduce the oxides and transform them into carbides.

The further treatment in the electric furnace gives a mass of carbides of uranium, tungsten, vanadium and molybdenum, which if cooled quickly on removal from the furnace can be easily pulverized. The powdered carbides are treated with water at 60 deg. C. Uranium carbide decomposes water, giving hydrated uranium oxide, green at first, but rapidly becoming blackish on contact with air. This precipitate is separated by flotation and dried and calcined. It then serves for the electric preparation of the pure metal or of its alloys or for the manufacture of uranium compounds such as the nitrate of alkaline salts.

Treatment of Residue

The residue from the treatment with water contains all the unattackable carbides and silicides. It is dried and treated with potassium nitrate to fusion resulting in a mixture of the alkaline vanadates, tungstates, molybdates and silicates. This fusion is dissolved in hot water and hydrochloric acid added. Tungstic and silicic acids are precipitated while molybdenum and vanadium remain in solution with any phosphoric acid. After filtration and washing of the precipitate tungstic acid is separated from the silica by fusion with bisulphate of potassium. The product of this fusion is dissolved in water, which removes potassium sulphate and leaves a white residue of tungstic acid and silico-tungstate of potassium. The residue is treated with cold water to which is added ammonium carbonate, dissolving the tungstic acid and leaving the silico-tungstate undissolved.

In the solution coming from the first operation and containing molybdenum and vanadium it is extremely difficult to remove phosphoric acid, and it is preferable in practice to precipitate it as ammonium phosphomolybdate. The solution is concentrated and ammonia is added until a yellow precipitate is no longer formed. Filter, and in the filtrate the vanadium present may be precipitated as ammonium vanadate by adding ammonium carbonate and crystals of ammonium chloride. The filtered liquid contains only ammonium molybdate, that is if all the molybdenum has not previously passed into the phospho-molybdate. The ammonium molybdate is obtained by concentrating to dryness and calcined in the air to molybdic acid.

Finally, molybdic acid may be separated from the phospho-molybdate by dissolving it in a concentrated ammoniacal solution and adding chloride of magnesium to precipitate the phosphoric acid as ammonium-magnesium phosphate.

Dr. S. C. Lind, Bureau of Mines, Golden, Colo., contributed a discussion in which he called attention to the radical change which had occurred in the last ten years regarding the rare elements. Pitchblende, formerly the chief ore of uranium, has been relegated to secondary importance by the carnotite of Colorado and Utah. Furthermore, uranium, formerly the principal product of the treatment of pitchblende, is now almost a by-product, with radium of primary importance. This has altered the metallurgical processes, and has brought into prominence that using an initial nitric acid leach as opposed to the older methods using sulphuric acid which throws radium into the tailings as a sulphate.

Electrolytic Silver and Gold Refining

Mr. George G. Griswold gave the following account of the Moebius process: "The first electrolytic plant for the treatment of doré bullion was put in at the Kansas City Smelting & Refining Co., Argentine, Kansas, in 1884 or 1885 by Dr. Moebius. This worked entirely satisfactorily, and was followed by other installations. The second was at the Perth Amboy plant of the American Smelting & Refining Co. These were of the Moebius vertical type. Dr. Moebius afterward patented a horizontal system with traveling silver belts for cathodes, a small installation of which was made at Perth Amboy, but did not prove as satisfactory there as the vertical type. When the parting plant was destroyed by fire, in 1897, it was decided to install the vertical system in the new plant. The decision to adopt this system was due to its greater capacity for a given floor space, smaller tie-up, and the fact that being run in connection with a lead refinery the anodes could be cheaply made 990 fine or better.

"The new tank room contains twenty-four sections of six tanks each, the sections being in series and the tanks in multiple. In the original installation the tanks were made of wood, which was never very satisfactory, and consequently stoneware tanks were used in the new plant.

The Anodes and Cathodes

"The anodes, weighing about 100 ounces, are cast by hand in the lead refinery and transferred in locked steel boxes, by a storage battery truck, to the parting plant. They are weighed, counted and punched, and are then used as required. The punching gives a slight depression on each side of the ear of the anode, thus furnishing a secure hold and better contact for the spring clips

which support them. The cathodes were made from cold-rolled silver sheets $\frac{1}{32}$ in. thick. There are 4 bags and 5 cathodes in each tank, and each bag holds 4 new anodes. Seventy-five per cent of the silver is deposited in 24 hours. It is constantly brushed from the cathodes by wooden sticks, rigidly attached to a wooden frame having a reciprocating motion, which serves to prevent short circuiting and also to give circulation. The deposited silver falls into wooden silver boxes, and is removed daily by dropping the hinged bottom of the silver boxes, which dumps the silver into a tray from which it is emptied into a wooden silver-car, provided with a false bottom and filter. The car is transferred to vacuum boxes, the silver washed, and then transferred to the melting room, where it is dried, melted, and cast into bars.

"The electrolyte is a neutral nitrate solution containing 15 to 20 grams silver and 30 to 40 grams copper per liter. Silver nitrate is added as required, and enough electrolyte withdrawn daily to keep the purity up to standard. The waste electrolyte is put in a wooden tank and the silver precipitated on copper, after which the copper is cemented out on iron and the resultant solution, after passing over lime, thrown away.

CURRENT

"Current was supplied by an engine-driven generator in the same building and a current density of 19½ amp. per sq.ft. carefully maintained; but later it was found more advantageous to install a motor-generator set in the central power plant, and to increase the current density to 40 amp. per sq.ft., which increased the capacity accordingly. The current is carried from the switchboard by copper cables which distribute it through mercury-filled copper cups over ¼ in. cold-rolled copper bus-bars, the end ones being bent to fit into the mercury cup when lowered into position.

"The bags which contain the gold slime are removed at regular intervals, and the contents sluiced into the gold box, thoroughly washed, transferred to iron boiling kettles, and treated with H_2SO_4, 66 deg. B., to remove the copper and silver. The gold slime is washed, dried and cast into anodes for electrolytic refining by the Wohlwill process. The liquor from boiling the slimes is run into lead-lined tanks, and the silver precipitated out on copper. The copper-bearing solution then goes to the copper refinery.

"The Wohlwill installation has five cells, and is in series with the silver sections. At the time it was put in, owing to the war, it was not possible to obtain porcelain, and stoneware cells were used. With the high current density of 150 amp. per sq.ft. osmosis develops in the stoneware; also, as they crack with any unequal strain, it was necessary to place them in a lead-lined box filled with water heated by steam coils. The boxes are supported in a lead-covered table with cupped top.

"An interesting feature is the use of mercury cups on the ends of the copper bus-bars, whereby any unit or units can be cut in or out quickly by using cross bars, also of copper, with ends bent to fit into the cups.

"The cathodes are thin gold sheets, rolled from electrolytic gold, and are connected to the contact bars by bending one end of the sheet around them and clipping them fast.

"The electrolyte contains 30 per cent free HCl, 80 to 85 g. gold per liter, and varying amounts of platinum and palladium. When the solution accumulates a sufficient percentage of these latter metals, a portion is withdrawn, and they are separated, refined and sold as pure metals."

Process for Refining Nickel

MR. GEORGE A. GUESS gave a description of a new method in which impure nickel, containing copper and iron, is electrolytically refined, using it as anode. Iron goes into solution and accumulates there, but copper, which also goes into solution, is precipitated therefrom continuously by keeping powdered calcium carbonate (limestone) suspended in the electrolyte. An unusual salt is thus formed from the copper in solution, $2CuO.2NiO.SO_3$, completely precipitating out copper, which settles, with $CaSO_4$, as a mud. The cathode is enclosed in a canvas bag to keep it free from mechanical impurities. Glue is used in the solution. The cathode nickel contains usually less than 0.001 per cent copper. The mud is reduced by fusion to a nickel-copper matte, which is dead roasted, and then reduced to nickel-copper alloy, NiCu, which is used as anode in an ordinary copper refining bath to recover its nickel as sulphate.

Referring to MR. GUESS' paper, DR. HERING pointed out that in this case we have a suspension of solid particles in an electrolyte, and that they would migrate in a definite direction, usually with the current to the cathode. For this reason he thought it would be necessary to put a porous cell around the cathode to prevent the deposition of these solid particles, and he wondered whether the arrangement provided by the author would be effective. MR. HOGABOOM called attention to the use of glue in the electrolyte and said that his own experience was that glue produced dark and brittle deposits of nickel. He questioned the advantage of its use.

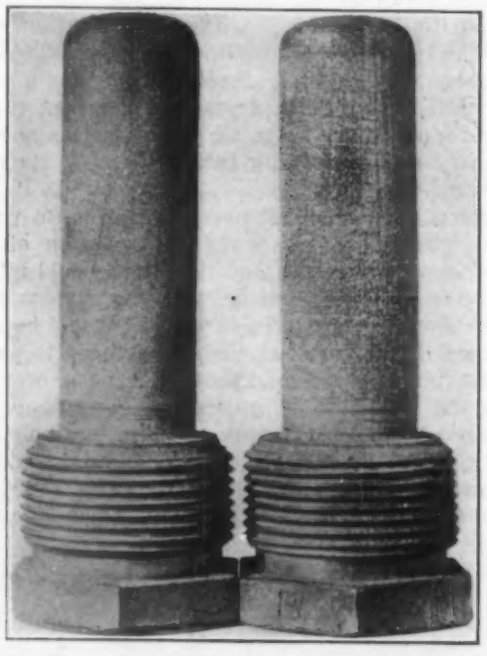
Electroplating

MR. OLIVER P. WATTS reviewed his investigations on electroplatings of copper upon iron by preliminary dipping of the iron article in solutions of various metals which lie, electrochemically, between iron and copper. Arsenic, antimony, bismuth, lead and tin dipping solutions were tried, and arsenic, lead and antimony solutions found effective in securing a good subsequent electroplating of copper. Even bismuth can be electrodeposited on iron by using a preliminary arsenic or antimony dip. Nickel can be deposited on aluminium by using a ferric chloride dipping solution. The paper will be published in a future issue.

In discussion one member related his experience with nickel-plated steel surgical tools. The plate peeled from these articles, particularly at or near the cutting edges. On careful examination it was found that there was a film of dirt on the steel wherever the nickel peeled, and investigation was made to ascertain how the dirt got there. It was believed that the dirt came from particles floating on the surface of the solution which would adhere to the steel articles when they were placed in the bath. It was also thought that these particles being submerged might be carried by the current and deposited on the articles. A preliminary copper plating was considered advisable in order to make the nickel more adherent.

MR. HOGABOOM was of the opinion that a dirt film on the surface of the bath would affect the articles regardless of a preliminary copper plate; and MR. REEVE

doubted if the dirt came from floating particles because it had been his observation that when articles were placed in the plating bath the surface film spread when touched and thus left a clean surface through which to insert the articles into the bath. He was of the opinion that the surface of steel was such that while it might appear to be clean, it would still have pin-holes containing dirt which would prevent good plating. He said that the "water-break" test is not adequate to determine the cleanliness of a steel surface. MR. MADSEN questioned the value of a preliminary copper plate in order to make the nickel adherent. He thought that floating dirt on the bath which might become wetted and sink would migrate with the current and be deposited in the plate. He thought also that impurities in the anodes



PITTING IN ELECTROPLATING

might act likewise, and that under certain conditions of current, temperature, etc., nickel oxide might be carried across. DR. RICHARDS thought that the whole trouble of peeling on sharp-edged tools would be avoided by making them of the alloy stellite.[1]

When making some lead platings, Mr. Watts observed that heavy pitting suddenly and irregularly appeared. After considerable study of the cause, it was finally found to be due to air dissolving in the electrolyte while it was resting over night and cooling, which was then expelled as minute air bubbles on the work when the bath was heated up by the passage of the current. The microscopic bubbles clinging to the work, which had been left immersed in the bath, started the pitting.

The difficulty was overcome by heating the solution to a little above its working temperature by means of a lead steam coil before resuming plating, whenever the tanks had been out of use for any considerable time.

MR. HOGABOOM reviewed his experiences with pitting in electroplating and exhibited a piece of silver plating on glassware which he had made many years ago. Various experiences and experiments confirmed him in the belief that the pitting was due to air in the solutions, particularly the surface layer of the solution in the vat. He thought that lead deposits were affected more than other metals by air in the plating solution.

[1]See this journal, May 15, 1918, p. 541.

Notes on Electrostatic Precipitation

MR. H. D. BRALEY reveiwed electrostatic separation of particles from gases and emulsions. The various applications discussed are: Recovery of metallic dust, of antimony, sulphur and arsenic, of potash, of sulphuric acid fumes and the dehydration of aqueous oil emulsions. Accounting data obtained from the International Smelting Co. show that the process has unquestionable financial merits. Separate discussions are given regarding the construction and operation of various types of treaters, temperature control as affecting operation, gas velocity during treatment, direction of gas flow, capacity of electrical supply, operating voltage, apparatus, transformers, generators, synchronous motors, rectifiers and accessories.

In discussion of this paper DR. DUSHMAN expressed the belief that the kenotron was more practical in current rectification than indicated by Mr. Braley. The operating temperature of the filament is about that of the ordinary incandescent lamp—far below the melting point of tungsten. He stated that the research laboratory of the General Electric Co. had perfected a control panel which protected the kenotrons against high-voltage stresses. The basic difference between the kenotron and the mercury-arc rectifier is that the former can be operated in parallel to get any quantity of power, which is not possible with the mercury-arc. Further, the kenotron can be operated up to 150,000 volts, and reduces to a minimum the surging in the precipitator circuit. He showed oscillograms of kenotron operation in comparison with mechanical rectifier operation, taken in co-operation with the Research Corporation. These portrayed the peculiar characteristics of the circuit of the Cottrell precipitator, one feature being the flattening effect produced on a high voltage wave due to the corona load. Others showed the smooth waves, both current and voltage, with kenotron operation, as compared with unsteady current conditions and distorted voltage wave with the mechanical rectifier.

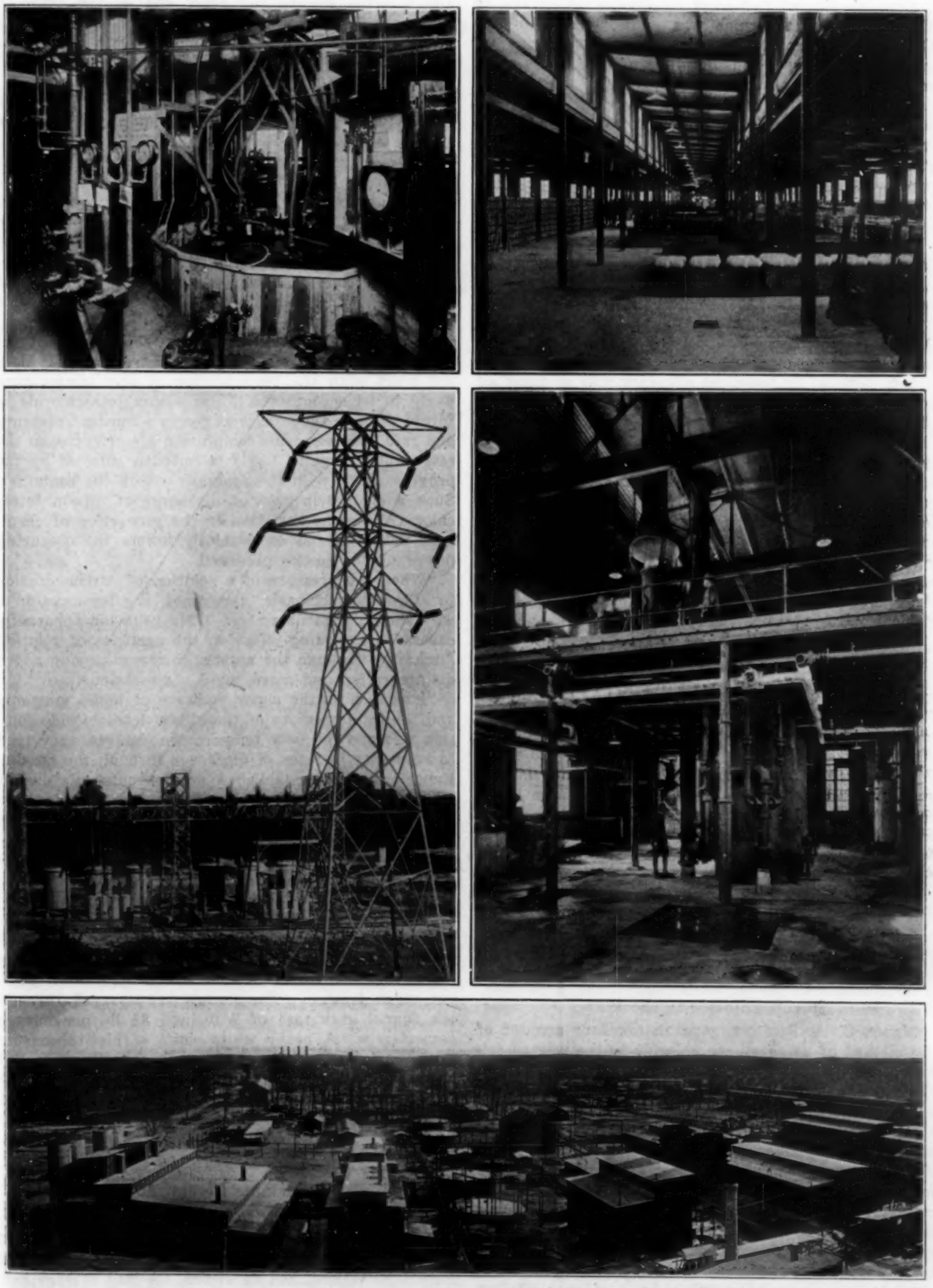
Nelson Chlorine Cell

MR. C. F. CARRIER of the American Cyanamid Co. gave the history and a description of the construction and operation of the Nelson cell. Because of the important part this cell has taken in chlorine production, the full paper will be presented in an early issue.

The illustrated lecture on oxidation of ammonia to nitric acid, by MR. W. S. LANDIS, was largely attended. The paper will be printed in full in a subsequent issue.

Symposium on Released Information

No body of scientists and engineers played a more important part in preparation for war than did the electrochemists. To their lot fell a vast amount of research, construction of tremendous plants and production of important munitions of war. Some of their achievements were disclosed for the first time in the symposium which the Society held on April 4. As one listened to the successive speakers, almost all of whom explained that their work had been interrupted by the armistice, one came to the conclusion that the said armistice was a great bar to scientific progress as well as to the defeat of Germany.



VIEWS OF EDGEWOOD ARSENAL

Upper left—Levinstein mustard gas reactor. Upper right—Shell storage. Center left—Transmission line and transformer station. Center right—CO gas producer. Bottom—General view of phosgene plant.

COL. W. H. WALKER gave an illustrated lecture on Edgewood Arsenal, which was a development of the Chemical Warfare Service constructed for the manufacture of poison gases and the filling of shells. He made some introductory remarks on the nature of gas warfare, along the lines set forth in our recently published interview[2] with Brigadier General Amos A. Fries, to wit, that it was not wholly to be condemned and that it had some commendable features. Colonel Walker also expressed the hope that the Chemical Warfare Service would be re-established and maintained as a separate and distinct branch of the military forces.

In the early days of our preparation for gas warfare it was expected that the toxic materials for shell filling would be supplied by manufacturers, but it soon became apparent that this would be inadequate and that a special plant would have to be built. Edgewood Arsenal was the result. Here the Government built and operated a plant of which the country may be proud, both as to technical efficiency and economy of construction. The gases produced by the service were phosgene, chlorpicrin and mustard gas, or dichlordiethylchloride. In the production of the latter our chemists developed a process of treating sulphur chloride with ethylene under proper conditions. This method was far superior to the chlorhydrin process used by the Germans. Colonel Walker spoke enthusiastically of the work of the first enlisted men who worked at the Arsenal, giving them credit for a large share in the general accomplishment. It was his opinion, also, that in no other munition plant was there gathered together so efficient and loyal a body of scientists and engineers.

Smoke Screens

MR. OTIS HUTCHINS gave an account of the experimental work done in the laboratory of the Carborundum Co. on the production of silicon tetrachloride. A charge of 80 lb. of silicon carbide was packed around a carbon resistor consuming a current of 15 kw. at 15 volts. When heated to the temperature of reaction, chlorine gas was conducted through the mass and silicon tetrachloride obtained by leading the gas through a water-cooled condenser. An average of 20 lb. of $SiCl_4$ was produced per hr. which was limited only by the available chlorine supply. The efficiency of the reaction was from 85 to 90 per cent. About 1500 lb. of $SiCl_4$ was made in all. Silicon tetrachloride was tested out comparatively with the other well-known chlorides of zinc, aluminium, phosphorus, etc., in organic synthesis, but was not found of any special applicability.

Silicon Chloride in the War

MAJOR G. A. RICHTER gave an excellent account of the method of using silicon chloride in the war as follows:

"The funnel is a smoke device attached to the deck of a vessel and operated to produce a smoke screen as a protection against submarine attacks. It consists of a horizontal cylinder about 6 ft. long and 28 in. in diameter, provided with suitable connections for the introduction of silicon tetrachloride and ammonia under most advantageous conditions. One end of the cylinder is equipped with a hand fan, the function of which is to furnish large volumes of air for dilution of the respective vapors before mixing. The silicon tetrachloride is vaporized through a bank of very efficient spray nozzles located about 12 in. in front of the fan and directed toward the other end of the cylinder. The ammonia is introduced through another spray nozzle located about 12 in. from the exit end of the cylinder and also pointed toward this end of the apparatus.

"The ammonia is forced through the nozzle from a steel cylinder by means of its own vapor pressure. The silicon tetrachloride is propelled from a second steel cylinder by means of dissolved carbon dioxide. The tetrachloride line running from the cylinder to the nozzles is provided with a glass-wool strainer to remove any particles of sediment which may accumulate in the system on standing. To operate this smoke device, both valves leading from the tetrachloride and the ammonia reservoir are opened wide and the hand fan at the rear of the funnel revolved in order to provide sufficient air dilution of the vapors.

"Dry carbon dioxide was selected as a propellant for the silicon tetrachloride for several reasons. It does not react with the tetrachloride at any temperature likely to be encountered. The silicon tetrachloride is forced through the nozzles at nearly a constant pressure and rate, whereas with compressed air or nitrogen the rate of discharge of liquid is seriously affected by the progressive drop in the pressure within the container. Such a change in rate of discharge of silicon tetrachloride causes a variation in the proportion of chemicals delivered and consequently lowers the obscuring power of the smoke produced.

"When the pressure of a solution of carbon dioxide in silicon tetrachloride is released, it effervesces in a way similar to soda water. This behavior apparently causes an exploding effect on the particles of solution discharged through the nozzles, thus resulting in added disintegration and more rapid vaporization.

"Inasmuch as the vapor pressure of liquid ammonia and the total pressure of the silicon tetrachloride solution rise and fall with temperature changes, they tend to keep pace in rates of discharge through the nozzles. Experimentation established an optimum mixture of 12 per cent of carbon dioxide in the silicon tetrachloride. Under a surveillance temperature of 60 deg. C. this composition will generate a pressure of 600 lb. to the square inch. At —26 deg. C. this pressure drops to 225 lb. These experiments were conducted in a vessel two-thirds full of the liquid mixture.

"Every effort is made to duplicate as closely as possible in a practical way those conditions which proved most efficient in the laboratory. A ratio of two parts of tetrachloride to one of ammonia is maintained without much trouble. The liquids are sprayed through the funnel at a rate of 7 lb. and 3½ lb. per minute respectively. A heavy white cloud of high obscuring power is formed. It is easily set up, readily controlled and is so nearly neutral in composition as to allow the vessel generating the smoke to pass through it. A single pair of cylinders contains sufficient material to generate an efficient cloud for a period of thirty minutes."

A Portable Precipitator

LT.-COL. ARTHUR B. LAMB gave the details of the miniature Cottrell portable precipitator which he and his research staff, Capts. Gerald L. W. Wendt and Robert E. Wilson, had developed. A lead storage battery in a special form offered the best supply of current so far as weight efficiency was concerned—30 watt-hr. at ½ amp. for 10 hrs. with a weight of 3 lb.

[2] See this Journal, Feb. 15, 1919, p. 152.

The best induction coil was a special design furnished by the Samson Electric Co. of Canton, Mass., having an input of 5.8 volts with 0.46 amp., an output of 875 volts with 16 microamp., and an efficiency of 0.52 per cent. The weight of the coils were 14 ounces.

As many tubes as are necessary for the air volume required are used, connected in parallel. In its present form the precipitator uses four glass tubes 1½ cm. in diameter and about 12 cm. long, each wrapped in a strip of copper gauze. In a production form these glass tubes will presumably be replaced by thin tubes of iron or aluminium, glazed or enameled on their inner surface. The inner electrodes are made by cutting a strip of copper-wire cloth of fine mesh in such a way that only two adjacent parallel strands are included, together with the correspondingly short lengths of the many crosswise strands cut. This is then twisted lengthwise through four or five axial turns, and the ends of the long wires are inserted into the heavier electrode holders and insulated from the outer electrode tube.

The weight of the precipitator proper is less than a pound, and when manufactured in quantity need not exceed a few ounces.

EFFECT OF RATE OF FLOW ON PRECIPITATING EFFICIENCY OF SINGLE TUBE

Rate of Flow Liters per Minute	Efficiency Against NH_4Cl Smoke 1 in 10,000
3	100%
5	100%
10	93%
15	85%
25	79%

These results indicated that for a man exercising only moderately, four or perhaps five tubes should afford adequate protection against any toxic smoke. A full-size portable outfit was therefore roughly constructed and tested out in the main testing chamber by wearing it in a cloud of diphenylchlorarsine smoke set up by detonation. Such a test has been found to penetrate all except the very best filters within a few minutes, but the man wearing the electrical precipitator was able to remain for a full hour without suffering any discomfort whatever. This indicated conclusively that the smoke precipitation was complete under these conditions. There was no appreciable resistance to the flow of air through the precipitator. A canister containing gas-mask absorbent was, of course, used between the precipitator and the wearer in order to remove any toxic gas or vapors which might be present. It was found to kill bacteria suspended in the air drawn through it.

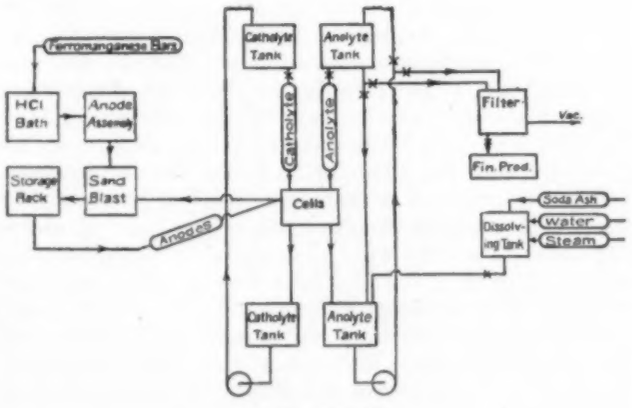
In discussion of Mr. Lamb's paper, MR. MESTON expressed the belief that it would be possible to get the same results with alternating as with direct current—with an induction coil as well as with a storage battery. DR. BANCROFT told of a small Cottrell precipitator which had been made for analyzing smokes, and MR. WILSON referred to the use of the apparatus in hospitals where it had been found much more efficient than the felt gauzes used in contagious diseases. DR. C. A. DOREMUS offered a note on the use of electrostatic precipitation in the manufacture of white arsenic from mispickel, or arsenopyrite. The ore was concentrated and roasted, and the fumes collected in a Cottrell precipitator.

Electrolytic Sodium Permanganate

MESSRS. ROBERT E. WILSON and W. GRENVILLE HORSCH reviewed the development of the ferromanganese electrode sodium permanganate process and gave the following account of the commercial half-ton plant:

"All things considered, the batch system of operation is the one best suited to the electrolytic production of sodium permanganate. Among the chief factors that lead to this conclusion are the simplification resulting from doing the cooling in one place outside of the cells, and the avoidance of the necessity for careful adjustment of the rate of circulation. Furthermore, uniformity of operation is gained by having all the cells throughout the plant operating on electrolyte of the same composition. With the batch system, the process will be intermittent with respect to the product turned out, but continuous in the sense that the current will be kept passing constantly through the cells, which will never be emptied of electrolyte except for purpose of cleaning and of renewal of the diaphragms.

"The interval of time selected for turning out of a single batch is one week. This interval is fixed by the amount of solution placed in the anolyte system and the final concentration of permanganate to be attained in the cells. One week is selected because if the interval is much greater the tankage required becomes excessive. On the other hand, if the interval is much less than one week the 'turn-over' becomes too frequent, resulting in increased labor requirements, and the condition is



FLOW SHEET

approached of having too small a volume of liquor to permit enough being outside the cells for adequate cooling and for settling out of the sludge.

"The concentration of sodium permanganate to be attained in the cells is limited to about 8 per cent, for the reasons previously pointed out. Fortunately, the evaporation of the solution may be carried out easily and inexpensively and if 30 per cent solution is to be produced, as was desired, it makes little difference in the final cost whether the evaporation is started from 8 or from 12 per cent.

"There are four principal operations to be carried out in this process; namely, the preparation of the solution, anode manipulation, filtration, and evaporation. When the plant is started for the first time an 18 per cent caustic soda solution has to be made up. During normal operation, however, there is only the simple preparation of a 12 to 14 per cent solution of soda ash.

"Anode manipulation is a question which demands more attention than it does in the majority of electrolytic processes. It is planned to have the cells arranged in banks of approximately eight each. It will then be possible to handle the anodes from all of the cells in one bank, simultaneously, using a small overhead crane. Thus, after shutting off the current from

the bank, eight anodes together will be raised, reversed, and lowered or carried to the sand-blast room to be cleaned, another set being put in their place. The sand-blasting can be effected while the anodes remain suspended from the trolley which conveyed them to the sand-blast room. The semi-plant scale experiments showed that the anodes would run more than twenty-four hours before needing reversing, and a slightly less time on the second side before removal altogether. It is therefore planned to make operations uniform by reversing the anodes in one-half of the plant each twenty-four hours, and to carry on replacement in the other half during the corresponding interval. This work would not, of course, consume the whole twenty-four hours, but could readily be carried out by two men during an eight-hour shift.

"In this process a sludge consisting of a mixture of the oxides of iron, manganese and silicon is always formed. It is planned to remove most of this by settling in the upper anolyte tank. For the purpose of washing the sludge and filtering the final product vacuum filters are installed.

"The power requirements and arrangement of circuits will be mentioned briefly. All the experiments which have been made are consistent with the belief that the energy consumption will be not greater than 12 kw.-hr. per lb. (26.5 kw.-hr. per kg.) of sodium permanganate produced. Allowing a loss of 3 per cent in evaporation, and, say, 10 per cent due to inactivity of a portion of the plant, a producing capacity in the cells of 1130 lb. (514 kg.) per 24 hr. must be allowed in order to turn out 1000 lb. (453 kg.) of the finished product. The power required is therefore found to be about 570 kw. It is planned to generate this power at about 112 volts. The cells will be connected in series-parallel, with a third wire running between in such a way that a single bank of eight cells may be cut out with very little disturbing effect on the current passing through the remaining cells. Running at a current density of 120 amp. per sq.ft., each cell exhibits a resultant drop in potential of about 7 volts.

"A design has been made and submitted to the Government giving rather detailed plans and specifications for a half-ton plant and including an estimate of the cost based on the best information in the light of all the work done. This estimate assumes the cost of raw materials, labor, and construction to be as they were in the year 1918, and provides for writing off the plant in two years.

"Based on these war-time conditions a fairly accurate cost of building and equipment (not including a substation, since the power cost estimate is based on 110-volt D. C., delivered to the plant) for such a plant is $85,000. Pure sodium permanganate in 30 per cent solution could be produced for about 60c. per lb. This cost can be further analyzed as follows:

Raw materials	$0.183
Power at $30 per hp.-yr	.067
Amortization	.120
Labor and overhead	.090
Contingencies	.140

Electric Furnace Manufacture of Silico-manganese

This paper dealt with war-time production of silico-manganese at Anniston, Ala., by the author, MR. B. G. KLUGH. The work was done in rectangular open-top furnaces comprising a steel shell 15 ft. by 7.5 ft. by 5 ft. high in one case, and 18 ft. by 9 ft. by 5 ft. high in another. The furnaces were 3-phase with 3 electrodes in line. Current was furnished at 22,000 volts and stepped down to 65 for the small and 100 for the large furnace. The raw materials used were silica rock, manganese ore, limestone and bituminous coal. The analysis of a 50-ton lot was Mn, 65 per cent; Si, 21; Fe, 13; C, less than 1. The following data relate to this product:

Ratio of ore to metal	3.53
Mn charged in metal, per cent	73.00
Mn charged in slag, per cent	10.02
Mn charged in gas (by diff.), per cent	16.98
Total weight of charge in metal, per cent	16.11
Total weight of charge in slag, per cent	31.34
Total weight of charge in gas, per cent	52.55
Pounds slag per ton of metal	4,358
Pounds gas per ton of metal	7,308
Pounds electrode per ton of metal	168
Pounds reducing carbon per ton of metal	1,715
Kw.-hr. per ton of metal	9,000

The author realizes that these results are not ideally economic, but presents them as showing what was accomplished under war-time conditions. In 1918, due to the shortage of manganese ores, the company made use of high-manganese slags from former operations, also from blast-furnace operations. One hundred tons of metal produced averaged Mn, 70 per cent; Fe, 9; Si, 20; C, less than 1. The treated slag and that resulting from the smelting had the following percentage compositions:

	Mn	SiO_2	Al_2O_3	CaO	MgO	BaO
Slag treated	20	34	14	25	2.0	1.5
Slag produced	1	29	23	42	2.7	1.6

Current consumption was 15,000 kw.-hr. per ton of metal. Mr. Klugh states that no difficulty is experienced in producing alloys of specified composition, within the limits of analytical error, and believes that if steel makers desired a certain SiMn alloy it could easily be furnished and replace the use of ferromanganese and ferrosilicon.

Lead Plating

MR. A. G. REEVE gave an interesting account of leading gas shells. Shells, copper "struck," filled with lead bath, anode and paddle, were placed on the plating bench (fifty-two 75 mm., 4.7 in. or 155 mm. shells per bench unit), anode and paddle quickly attached to the rotating spindles, and deposition begun.

Each spindle could be raised and disengaged from the driving pulley independently. The entire frame carrying the 52 spindles could be readily raised or lowered to suit the various shell sizes.

Current was supplied to the spindle through its two babbitt bearings set in woodwork. To use the available ampere-hours advantageously, the 52 spindles were divided into four batteries and connected in series, with 6-volt plating current, the 13 spindles of each battery being connected in multiple. To insure uniformity each shell was given a new anode, the old ones being re-cast.

The specification for gas shells required that the thickness of plating should not be less than ten nor more than fourteen thousandths inch (0.25-0.35 mm.) for all sizes, except that five thousandths (0.125 mm.) was desired on the threads in the opening. This was accomplished by withdrawing from the shell, when half plated, a small portion of the bath by use of a rubber bulb and a brass tube bent at the end so as to reach down only the required distance into the shell opening. To further equalize the thickness of deposit, each shell was turned part way around on its axis several times during the plating period.

The following table gives approximate data on the

volumes, areas, amperes, and time, etc., for three shell sizes:

	Exposed Anode Surface, Sq.In.	Cathode Surface Sq.In.	Ounces Lead Deposited	Amperes	Hours
75 mm.....	11.50 (18 sq.cm.)	64 (100 sq.cm.)	4.51 (127 g.)	5	6.63
4.7 inch.....	20.07 (31 sq.cm.)	147 (229 sq.cm.)	10.21 (289 g.)	10	7.50
155 mm.....	37.06 (58 sq.cm.)	266 (412 sq.cm.)	18.61 (529 g.)	20	6.84

The bath as received from the refiners ready for use analyzed about as follows:

Deg. Baumé	Per Cent Pb	Per Cent H_2SiF_6	Per Cent Free H_2SiF_6	Per Cent Glue
43	18.02	14.14	2.90	0.4

This was supposed to work best at 95 deg. to 100 deg. F. (35-38 deg. C.) with from 2 to 5 per cent free acid, and in practice it was found that the resistance of the bath was such that with 6 volts the shells and bath soon warmed up to the desired temperature while the plating was going on.

Regardless of the recommendations of those who furnished the lead bath, the quality of the deposit was materially improved by the addition of 2 lb. of glue to each barrel (50 gal.) (5 g. per liter) of new bath before using. As fast as the plating operation was completed the bath was poured out of the shells and filtered, and one lb. of glue added per barrel of bath (2.5 g. per liter) each time it plated a set-up of shells. The number of shells set up for plating with one barrel of bath and the volume of lead deposited per barrel set up, are given below:

	75 mm.	4.7 in.	155 mm.
No. of shells filled per barrel (190 liters) of bath....	346.0	100	42.37
Lb. of lead deposited per barrel (190 liters) of bath.	97.3 (44.2 kg.)	64 (29.1 kg.)	49.30 (22.4 kg.)

It will thus be noted that in the 75-mm. shells each gallon of bath deposited nearly 2 bbl. of lead in 6.63 hr., with one glue addition. The discoloration which the exterior of the shells acquired was scoured off by a revolving brush with an abrasive and water.

MR. BLUM called attention to the extension of lead plating, saying that before the war there were but two or three places in the United States where it was done, and that within two months after war was on there were from 20 to 25 plants in existence. He believed that lead plating was likely to find new applications in industry because there was no difficulty in depositing coatings up to $\frac{1}{16}$ in. in thickness. In lining some catalyzers for the Edgewood Arsenal the Bureau of Standards had treated an area of over 50 sq.ft. and had deposited 275 lb. of lead.

MR. E. C. WALKER said that he had eliminated the difficulty of plating the bottom of the booster orifice by circulating the electrolyte and using still anodes, whereas the author of the paper had used rotating anodes.

MR. FRARY referred to Mr. Blum's work at the Arsenal and said that before satisfactory work finally was done there had been trouble with blistering in the lead coating itself. It was finally proved that the trouble was in the preliminary pickling of the vessel, and that when the surface was prepared by sand-blasting instead of pickling the trouble vanished.

MR. BRADLEY asked if the process could be applied to the lead-lining of pipes for resistance against attack of sulphuric acid. Mr. Reeve thought this could be accomplished without difficulty; and Mr. Walker mentioned the successful coating of pipes and buckets. The latter were used for carrying sulphuric acid, and had a coating 0.001 in. thick.

MR. T. P. BAILY gave a paper on the heat treatment of anchor chain, drawbar knuckles and aëroplane parts, and the melting of yellow brass, which was excellently illustrated with moving pictures. The heating is accomplished by an electrical resistor of granular carbon contained in carborundum fire-sand beds. The apparatus is controlled by pyrometers which maintain exactly the desired heats. Chains of 90 ft. length and 3400 lb. weight were treated at the National Malleable Castings Co. for the Emergency Fleet Corporation.

MR. GEORGE K. ELLIOTT described the experience of the Lunkenheimer Co. with duplex process iron castings. The molten iron tapped from the cupola was superheated in a basic electric resistance furnace. Improved fluidity was obtained due to the higher temperatures obtainable and, most important of all, the sulphur content was decreased from 0.1 per cent to 0.03 per cent in 25 minutes. The process presents an important field for future development where better strengths are required than can be obtained from ordinary cupola iron. Steel castings can readily be made, as there is no limitation to the heats obtained for fusions.

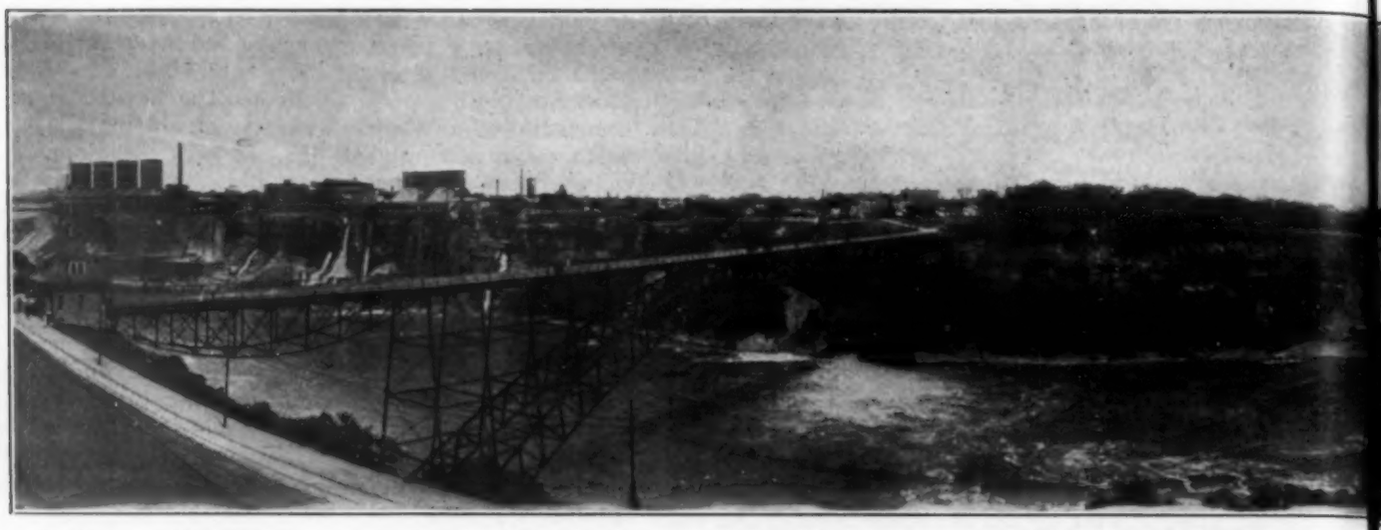
MR. W. E. MOORE discussed electric steel made in acid furnaces. He concluded that electric steel is superior to the product of the small ovenhearth or the converter in regard to costs of raw materials, alloys, refractories and composition control.

MR. C. S. COX of the Duquesne Light Co., Pittsburgh, read a paper on "Power Production for Electrochemical Purposes." He stated that steam-generated electricity can compete with hydraulic in all cases except where great natural advantages are found.

Resumption of Trade With Certain Countries

The War Trade Board has from time to time, since the armistice, announced the resumption of trade with certain countries in Europe with which trade was prohibited during the war by reason of the blockade.

In order that the business public may now have a complete list of these countries, the Board announces (W. T. B. R. 687) that trade has been resumed with Siberia (see W. T. B. R. 470, issued Jan. 3, 1919). Alsace-Lorraine (see W. T. B. R. 486, issued Jan. 8, 1919), Palestine and Syria (see W. T. B. R. 530, issued Jan. 20, 1919), Mesopotamia (see W. T. B. R. 560, issued Feb. 3, 1919), Servia and Roumania (see W. T. B. R. 551, issued Feb. 4, 1919), the territory included in the line set out in article 3 of the military clause of the armistice protocol of Nov. 3, 1918 (see W. T. B. R. 574, issued Feb. 4, 1919), Finland (see W. T. B. R. 590, issued Feb. 11, 1919), Czecho-Slovakia (see W. T. B. R. 594, issued Feb. 13, 1919), Bulgaria, Turkey, and Black Sea ports (see W. T. B. R. 602, issued Feb. 16, 1919, and W. T. B. R. 665, issued Mar. 24, 1919), German colonies (see W. T. B. R. 609, issued Feb. 21, 1919), the occupied territory of Germany (see W. T. B. R. 610, issued Feb. 22, 1919), Adriatic ports, Albania, and Montenegro (see W. T. B. R. 623, issued Feb. 28, 1919), Luxemburg (see W. T. B. R. 652, issued Mar. 17, 1919), the territory adjacent to and dependent upon the Adriatic ports, including Albania, Montenegro, Croatia, Slavonia, Bosnia, Herzegovina, and Dalmatia (see W. T. B. R. 656, issued Mar. 20, 1919), Poland (see W. T. B. R. 675, issued Apr. 1, 1919), Esthonia (see W. T. B. R. 676, issued Apr. 1, 1919), and German-Austria (see W. T. B. R. 679, issued Apr. 2, 1919).



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Buffalo Meeting of the American Chemical Society

Report of Acts of Council and Technical Sessions—Best Attended Meeting in the History of the Society—Sessions Enlivened by Successful Smoker and Banquet—Symposiums on Library Service and Mustard Gas

THE 57th meeting of the American Chemical Society at Buffalo was called "Victory Meeting," and it was very largely attended.

Meeting of the Council

The Council was called to order at the University Club at 4 p.m. on Monday, April 7, there being ninety-two Councilors present, the largest number that ever has been counted at one meeting. Aside from routine business, provision was made for specifications for standard laboratory apparatus and for specifications for a standard polariscope. The German instrument which was formerly used by sugar chemists differs from the French type, and presents some undesirable irregularities. A committee is to devise and recommend specifications.

It was agreed to urge as a basis for governmental action the appointment of a high commission to coordinate the natural resources of the country, and it was recommended that in the proposed international councils of chemistry both pure and applied science be included as component parts of it, rather than that their spheres of activity be divided. It was also urged that neutral nations be invited immediately to participate in the deliberations of the body, and to be represented in its membership. A division of Rubber Chemistry has been added to the Society, and it was announced that a Dyestuff Section, of which Dr. C. L. Reese is chairman and R. Norris Shreve secretary, will function at the September meeting in Philadelphia. Reports of many committees were read.

It was decided that all papers presented at any meeting of any section are properly available for publication in the Society's journals and may only be released under permission of its editors.

During recess, at the invitation of the Western N. Y. Section of the Society, the Council dined at the University Club, and immediately afterward resumed its session.

Discussions of Reports

The evening was devoted to discussions of reports, among which was one on Co-operation Between Industries and Universities, and one on Compendia of Chemical Literature and that of the Clearing Committee. The report on Compendia, presented by Dr. Stieglitz, proposed that American chemists take up the preparation of critical volumes on physical and chemical constants and related numerical data (besides certain monographs in other fields as specified). This will leave to the British Commission the preparation of compendia of inorganic and organic chemistry, and to the French Secretariat of the International Commission on Annual Tables of Constants, etc., the continued compilation of non-critical abstracts of constants, numerical data, etc. Convincing reasons for this subdivision of the work were given. The business control of the publication it is proposed to vest in these trustees.

It was in December last that President Nichols called a meeting of the Council to consider proposals in relation to reconstruction. The proposals were at once so multitudinous and miscellaneous that they were referred to an omnibus or clearance committee of which Dr. Arthur D. Little was chairman. The committee laid away in cold storage a large number of recommendations that were evidently designed for other worlds than this, and proceeded to work out into definite shape and form, those that might, could, would or should be undertaken. The whole series offered enough opportunities to appease the most insatiate workers, with

American Falls | Goat Island | Horseshoe Falls | Niagara Falls Power Co. | Victoria Park

enough left over to last, as somebody said, about a hundred years. It is to be printed and circulated for discussion later.

The General Meeting

On Tuesday morning, April 8, the general meeting was held in the ballroom of the Hotel Statler at 9.30 o'clock. There was standing room only, and not much of that. The reason for this was due to the habit of members of the Society to refrain from advising the secretary whether they intend to be present or not, and then coming in great numbers. Out of a total registration of 1150 only 150 had signified to the secretary their intention to be present. The contribution of CHEMICAL & METALLURGICAL ENGINEERING of a printed registration list in convenient form which appeared every afternoon seemed to find favor. It gave the name and address in Buffalo of every registrant.

The HON. GEORGE F. BECK, Mayor of Buffalo, made a short speech of welcome in which, possibly instigated by the threatening rain, he expressed regret that the Society had chosen a season for its visit when the climate of the city was less attractive than at other times. Those who are familiar with the cold blasts of Lake Erie in the Fall and Winter were content to be present in the Spring. He cited statistics relating to the city among which was contained the information that in 1828 one-third of the traffic of the Erie Canal was taken up with the transport of whiskey.

DR. NICHOLS responded in his usual happy manner, after which, in a business meeting that followed, PROFESSOR GIACOMO CIAMISIAN of Bologna, Italy, was elected an honorary member.

DR. (LIEUTENANT-COLONEL) WILDER D. BANCROFT, who is the first of the annual chairmen of the Chemical Section of the National Research Council, reported that that body will now continue its activities on a peace basis. He announced that the Rockefeller Foundation had set aside $500,000 to be spent within the next five years for fellowships in research in chemistry and physics. The minimum fellowship is to be $1500 annually, and it is intended to make these the equivalent of post-doctorate fellowships, although it is not demanded of aspirants that they have Ph.D., or Sc.D. degrees. There are no strings whatever attached to the offer. Anybody who has research in hand or under consideration may apply. He may choose his own subject and his own institution of learning, subject, of course, to the approval of the committee which has the matter in charge. It is hoped to continue good men in research on some problems for terms of two or three years, so that work may be brought as nearly as possible to completion. The committee is ready now to consider applications. It is really an extraordinary opportunity. All that is required is qualification in scholarship and ability, and merit in the subject. Applicants should address Dr. Wilder D. Bancroft, Chairman Division of Chemistry, National Research Council, Washington, D. C.

The President made an appeal on behalf of the children of French chemists and engineers who, as officers, have fallen in the war. This supplemented a similar appeal from Secretary Parsons at the meeting of the Council.

President Nichols' Address

PRESIDENT NICHOLS then made a short address on reconstruction. He declared that the way in which reconstruction problems are solved will be of vast influence, either for good or for evil, for the next century. Without doubt peace terms will soon be agreed upon, and we then should prepare ourselves for peace. Until lately public and private interests have been subordinated to winning the war. In making the change we must bear the public welfare in mind, and remember that we cannot possibly return to the conditions of five years ago. Awful damage has been done, and things cannot be made the same as they were. Revolution has been in process for some time, and revolution can be just as effective, even if we see but little of it on the surface, as if it were to march with plumes and banners. Great changes have taken place, among which we must count the enormous additions to public debts which are said at present to exceed $315,000,000,000. Now the honest thing to do with debts is to pay them, and reconstruction must look forward to eventual liquidation.

SHOULD SEEK PATH OF WISDOM ON LABOR QUESTION

Many employers have been disposed to regard their employees merely as so many hands. Now the pendulum is swinging the other way, and labor is at times disposed

to hold that leadership and the administration of industrial affairs rest solely within its councils. It is our business to seek the path of wisdom, and not alone to find it, but to demonstrate that only by the earnest co-operation of labor and capital, working in harmony and not at cross-purposes, can industry endure. We must bear in mind that quality of product, efficiency of work, and right living under wholesome conditions, are important things, and that wages are subsidiary to them.

Another silent revolution has been the change in the character of our population within the last fifty years. Many of our new citizens have brought with them old-world theories of the inviolability of force.

Prohibition, which we awoke one morning to find all inscribed upon the Constitution, is not a subject the merits of which we should discuss at this place. But we must beware lest so important a material as ethyl alcohol be legislated out of industry as well as out of drink.

The conservation of our national resources, including water power, forest products, and many other sources of wealth, is a very pressing question. Dr. Nichols urged all present to read an article in the March number of the *Atlantic Monthly*, by Dr. Arthur D. Little, entitled "Developing the Estate," to learn of our wasteful extravagance, and of what we should do to prevent it. He expressed the opinion that our great stores of sulphur should not be used where pyrites and sulphurous ores could be roasted to provide what is needed, and he believed that the great opportunities for chemists is to be found along the lines of conservation.

In regard to unrest among workers he pointed out that many employers have been guilty of unfairness. There has probably been less of this than many suppose to be the case, and the condition of the worker has been constantly improving for as long a time as he could remember. Nevertheless the unrest continues. Now, if the present system results in continuous improvement, it is a fair question to ask why it should be changed, as many demand, for something which, as evidence shows, produces nothing but sorrow and destruction. He believed that the only affirmative answer to this is to be found in the propaganda of men and women who can make an easier living by talking than by working. During the reconstruction period we must demonstrate conclusively that our present civilization is based on justice and equity for all. By this means we can set at naught the eloquence of the professional agitator.

Tariff Commissioner Culbertson

The HON. WILLIAM S. CULBERTSON of the U. S. Tariff Commission spoke on "American Chemical Industries and the Tariff Commission." The two outstanding forces which modified chemical industry during the war were the isolation of the Central Powers and war orders. The American public realizes now as it never did before the relation of chemical industries to the national welfare. The month of famine in dyes was the most potent argument it ever encountered in support of this thesis. There were other problems, however, which had to be met, and which were met, but were, of course, less spectacular. Among these were chlorine and chlorine products, barium salts, caustic soda and many others. The speaker thought that the importation of monazite sands from Brazil to make thorium nitrate, in Germany, and the following exportation to this country as gas mantles or preparations for mantles, was one of the most illuminating examples of how not to conduct an industry—so far as America was concerned. And the speedy development of the rare earth industry in this country under pressure of need he regarded as even more illuminating—as showing how things should be done.

The same conditions that obtained in this country operated also in Great Britain, Norway, Sweden and Japan. They have been busy to capacity, supplying war needs until lately; and now they must look for other markets. Investigation of commercial policies is greatly needed, as well as an assemblage of facts related to them.

The war solved some problems in chemical industry, and it created others. It also taught us certain things, among which we may mention for example, the fact that a policy of *laissez faire* has no place in chemical industry.

In the mind of the speaker there is no question that the coal-tar dye industry needs protection. As soon as hostilities ceased Great Britain took steps to conserve her own dye industry by prohibiting all imports of dyes, except such as are authorized by a licensing board, Mr. Culbertson felt that we cannot adopt such a measure, and that we must find our safeguard in the tariff. Our industry is doing business on a lively scale, but it cannot be expected to be able to accomplish in four years what the Germans did in forty to fifty years. The Germans have the advantage of priority in the art, and they have always taken advantage of unfair practices. The difference in priority Mr. Culbertson believed could be met by the tariff, and such unfair practices as bribery and full-line-forcing by the Bureau of Foreign and Domestic Commerce. But dumping surplus stocks at less than cost to gain a market is another problem, and in order to meet this Mr. Culbertson proposes that the tariff law be supplemented, giving the President extraordinary powers to prohibit importations and to increase duties on all materials which he has reason to believe would be sold with a view to destroying competition.

Mr. Joseph H. Choate, Jr., on the Chemical Foundation

MR. JOSEPH H. CHOATE, JR., general counsel to the Chemical Foundation, spoke on "German Methods and Our Present Situation." He said that the efforts of the Alien Property Custodian had centered in the beginning on the dye industry, so far as chemicals were concerned, and that pharmaceuticals followed. Heavy chemicals in the U. S. seemed to be generally free from German ownership.

In regard to dyes the Germans held in substance a world monopoly, acquired by a combination of natural advantages, and sub-natural methods. They had cheap and docile labor and cheap chemists. They could combine into any kind of a tangle they desired, and the more they interlocked the better the government liked it. First they made two great trusts, and in time the twain became one. Manufacturing on a large scale brought down production costs, which gave a large surplus for export, and the government liked this too. The big trust was formed avowedly for foreign trade, and it has available capital of about half a billion dollars. It is a mighty power.

In the United States they found the dye business permeated with Germans and German chemists, but there was hardly a sign of German ownership, except

among three concerns which reported German ownership. This amazing manifestation of German integrity almost stunned them at first, but, after diligent search, an example of its working was discovered, in the Bayer Co. This concern had an enormous fund from goods sold in the East which could not be remitted to Germany. Among the many uses to which this fund was put was the secret purchase of a nice little going concern known as the Williams & Crowell Co., to which all the assets were being quietly transferred, so that when the Alien Property Custodian should take over the German-owned agency, he might receive an empty shell. When he included the Williams & Crowell Co. in his seizure there ascended unto the skies a high and mighty wail. Hoechst, Cassella and the Badische claimed to be owned by Americans, and the speaker believed that a great hazard to American industry was averted when the actual participation of the German trust in these concerns was smoked out. The Badische interests, for instance, were shown to have belonged always, from the very beginning, to American agents in New York. There was no record anywhere that the German company had been interested. But the remittance of $1,250,000 as dividends by the American agents to the Badische Co. within a rather short period of time was sufficient evidence to convince Mr. Palmer that the Badische Co., after all, was interested. The Hayden Chemical Co. and the Bauer Chemical Co. transferred their stocks in February, 1917, to their general counsels, but the purchasers did not pay for them. German ownership has been pretty well brought to light, he believes.

How Best to Protect American Industry

But there remains the great trust. What has it been doing during the years of the war? Of course we don't know, and without doubt some of its branches have been making munitions. It is fair to believe, however, that vast quantities of cotton vat and other much-desired dyes are stored up, ready to be thrown upon the market here at any price. Mr. Choate did not see how a tariff alone can protect the American dye industry. The German trust can afford to buck up against a 100 per cent tariff, and finally control the situation. He believed the industry in this country to be in a precarious condition, and said that in considering the matter the Alien Property Custodian had come to the conclusion that the only way to stave off a recurrence of the German monopoly was by seizing their patents and preventing control from that source. The Chemical Foundation was therefore formed which purchased in fee all German chemical patents from the U. S. Government, for $250,000. As an organization designed to benefit chemical industry in the U. S. it is hoped that as time goes on the Foundation may buy other patents and continue indefinitely to sell rights under them. But all of these measures will not suffice, in the views of the speaker, to conserve the industry against an antagonist so strong and unprincipled as the German syndicate, unless our Government follows the lead of our British cousins by taking the bull by the horns, and prohibiting imports of dyes, save under a specific license in each individual case.

This was followed by a very pretty little tilt at argument in which Mr. Choate favored the license system and Mr. Culbertson opposed it, in the belief that a proper tariff provision would be an adequate protection for the United States.

Mustard Gas Symposium

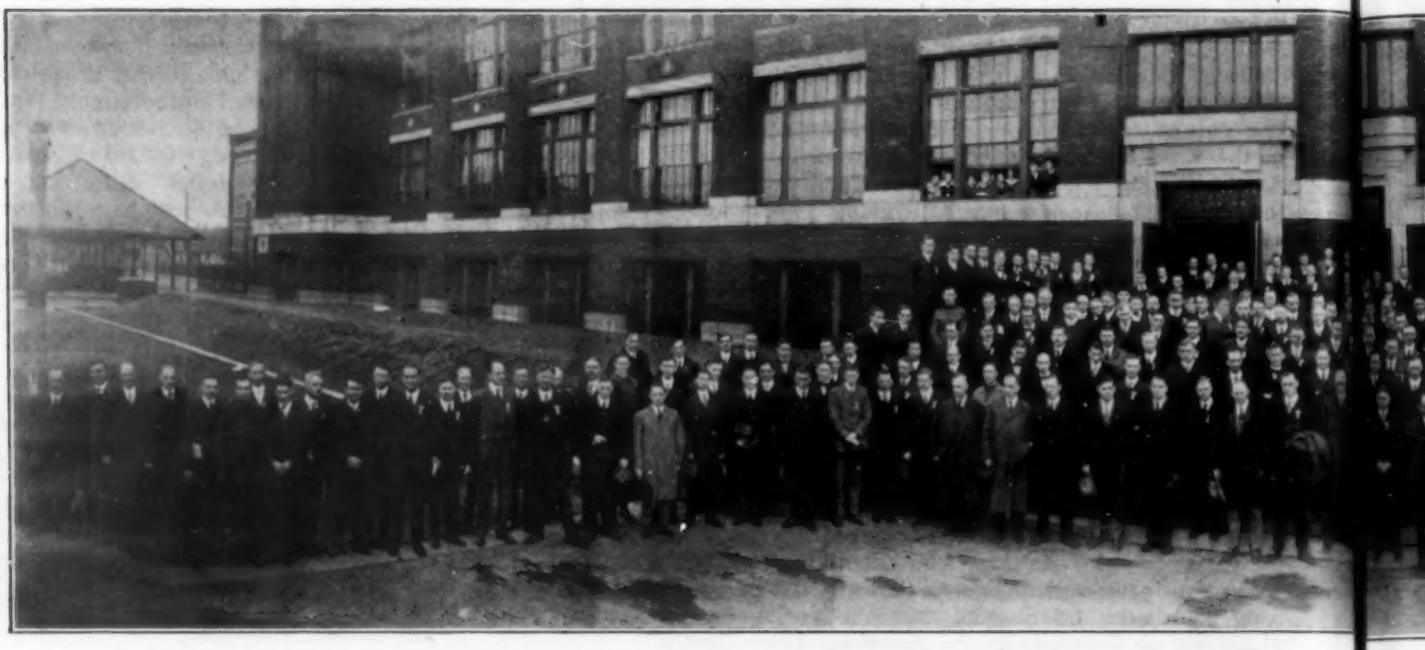
On Tuesday afternoon there was held a symposium on Mustard Gas, in the auditorium of the Technical High School. It covered the ground so thoroughly that it became necessary to continue the discussion over to Wednesday morning, drawing a large attendance. Space forbids our reporting the papers in detail, but we cannot suppress the wish that the entire proceedings might be recorded in a separate volume. Despite what appears to be the conclusion of certain governmental authorities to break up the Chemical Warfare Service by extracting the chemistry from it, separating defense from offense, destroying the works, and vesting whatever authority may remain in men with neither training nor experience nor interest in chemical warfare, we know that chemical warfare is here to stay. To the nation at war that is not prepared against it it assures certain defeat, while to the army that is prepared, it is the least dangerous and most humane of all methods of attack. In the interest of the general welfare the chemists of the country should preserve as much as they can from the official discard.

Divisional Meetings

On the morning of Wednesday, April 9, the Divisional Meetings began, and the most important paper of the whole convention was then presented by Dr. Irving Langmuir of the General Electric Laboratories, before the Division of Physical and Inorganic Chemistry, on "The Arrangement of Electrons in Atoms and Molecules." A well-known chemist declared the occasion to vie in importance with the first presentation by John Dalton of his atomic theory. Dr. Langmuir spoke for an hour and a half, before an audience that crowded nearly every square foot of space, and he spoke as one inspired. Later numbers of the journal of the Society will print his exhaustive presentation of the subject, but we are sure that all his hearers will remember the occasion. He started with the theory of "The Atom and the Molecule" as presented by G. N. Lewis, and followed it as far as it went. Then, by a series of postulates, which we shall not repeat because they would require explanatory comment to bring them into correlation, he arrives at a structural theory of the atom which becomes a complete working hypothesis, explaining valence, the irregularities of the periodic law, compounds of the CO type, and the theory of Werner. So profound was the impression made by this masterly presentation, that by urgent request it was repeated on Thursday morning before the Division of Industrial Chemists and Chemical Engineers in the auditorium of the Technical High School.

Preferential Catalyses in the Purification of Hydrogen

Professor H. S. Taylor of Princeton followed with a short talk on "Preferential Catalyses in the Purification of Hydrogen" which contained an interesting statement, and a suggestion that is well worthy the attention of industrial chemists. He desired to oxidize CO, contained as an impurity, to CO_2. With Ni he oxidized hydrogen also, to water, but FeO_2 he found to be selective. Trouble was the process was slow. By mixing two catalytic agents in the proportion of 85 to 15, viz.: FeO_2 and Cr_2O_3 the reaction was speeded up 700 times. Professor Taylor urged further research along the lines of these catalytic boosters, in the interest of better chemical control in technology.



In the Division of Industrial Chemists and Chemical Engineers the proceedings began with a series of twelve papers on Library Service in Industrial Laboratories. The contributions were from librarians engaged with the Carnegie Library of Pittsburgh, Dr. George W. Crile, Eastman Kodak Co., the Chemical Catalog Co., Arthur D. Little, Inc., National Aniline & Chemical Co., Inc., National Carbon Co., N. J. inc Co., Stone & Webster, the Solvay Process Co., The Barrett Co., and E. I. du Pont de Nemours & Co.

Uses for Libraries

Limitations of space again forbid details, but possibly the following argument may roughly cover the ground. If men are to work with their minds with a view to making needed things as well as possible, and as cheap as possible, it is part of the game to let them learn what others have accomplished along similar lines. The information is contained in periodicals and books. These are valueless unless they are available, and they are not available unless each is to be found in a particular place on a particular shelf. When this situation has been reached a library results. Now library service consists in telling the man who wants to know in which book or paper he can find the information he is seeking, and where to look for these. Titles often are misleading.

Other Papers

Dr. Adams T. Clarke told of the joys and sorrows of producing unusual organic compounds for chemical research, and expressed his obligations to many manufacturers for their assistance. Dr. W. J. Hale of the Dow Chemical Co. followed with the opinion that manufacturers should do more; that they should send their products freely, and that they should purify the materials themselves, as far as possible, which is often a much cheaper process for the original maker than for Dr. Clarke in his establishment. He wanted to see the prices for pure chemicals brought down.

Dr. A. G. Peterkin presented a paper on phenol, in which he reported 8,000,000 lb. as the annual pre-war consumption in the U. S. This was chiefly imported from England. During the war manufacture increased to the rate of 150,000,000 lb. annually, of which not over 2,000,000 lb. was distilled direct from coal tar. The Government now has from 30 to 50 million lb. on hand, and uses for it are wanted. When present stocks are absorbed there should be use for the output of one or two phenol plants in this country.

Dr. Paul Rudnick gave a series of tests of metals held in couples in solutions of $CaCl_2$, which are offered for sale as motor car anti-freezing mixtures. In many cases the metals held up well for eighteen days, but lost in weight seriously the ensuing week. His conclusions were not favorable to the use of $CaCl_2$ in automobile anti-freezing mixtures, and this was confirmed by a majority of those who followed him in discussion. One member had reached like conclusions, and had advised against such a mixture, but his advice was disregarded, and after two winters the old machines were still in running order. Against this, however, many machines were reported as seriously damaged after short use of such mixtures. Aluminium suffers most from them.

Three Papers by Dr. Baskerville

Dr. Charles Baskerville presented three papers. The first was on lead-coated iron sheets which were free from pin-holes. A roof made of this material has been exposed to the weather since 1914, and is still good. The second was a reinforced lead, of which he showed examples in sheets, similar to wire glass in its reinforcement. Seven-inch vacuum mains made of this material showed no tendency to collapse. The third paper had to do with "Utilization of Asphaltic Base Acid Sludge from Petroleum." The sludge is treated in the following manner: After heating to about 120 deg. F., the sludge separates into three layers, of which the bottom is concentrated acid, and is recovered. The middle zone contains the asphaltic bodies, which are washed with water, and treated with lime. A useful asphalt paper was shown, made of this recovered material.

Mr. R. O. E. Davis gave results of his work, showing difficulties in connection with CO in the Bucher process. The effects were found due to the small amount of CO_2 that is always in equilibrium. Eight-tenths of one per

cent of CO_2 totally inhibits the yield of fixed nitrogen. Four-tenths of one per cent permits a yield of 60 per cent, and the presence of one-tenth of 1 per cent or less has no effect. One of the mysteries still to be solved in the Bucher process is to determine what the product really is. It is neither a cyanide nor a cyanamide, but rather a mixture of several nitro carbides which have not yet been isolated and determined.

Social Features

The smoker on Tuesday night was about the liveliest entertainment of the kind we have ever attended. The chairman of the committee, Mr. F. A. Lidbury, is not given to inertia in the presence of opportunities to crack heads, and on such occasions he is no milder than a man from Kildare with a blackthorn. Nobody was safe after his name was called.

On Wednesday evening at 6 o'clock the members of the Council were entertained at dinner by one of their number, the Rev. M. J. Ahern, S. J., President of Canisius College, in the refectory of that institution.

At 8.30 on the same evening Provost Edgar F. Smith of the University of Pennsylvania delivered a very scholarly address to a large body of members and guests of the Society and Buffalo citizens in the auditorium of the Hutchinson High School, on "A Chemical Story." He brought out how the phlogiston theory met its original defeat in Philadelphia, at the hands of young James Woodhouse in argument with Joseph Priestly. He also gave a remarkable list of American origins in chemistry and physics that have been forgotten in the literature, and he made an earnest plea for their incorporation in text-books. Why American scholarship seemed to pass under a cloud in the first half of the nineteenth century and to forget even its own, is an interesting question which the good Dr. Smith did not undertake to answer—and this is no place to discuss it.

On Thursday evening the banquet was held, at which Mr. Lidbury presided as toastmaster. In this post he was almost as gentle as a dove—and yet not quite as gentle as a dove. There were many speeches, but none of them long. The toastmaster had a stop-watch and a bell.

Seeing Chemical Plant Apparatus Made

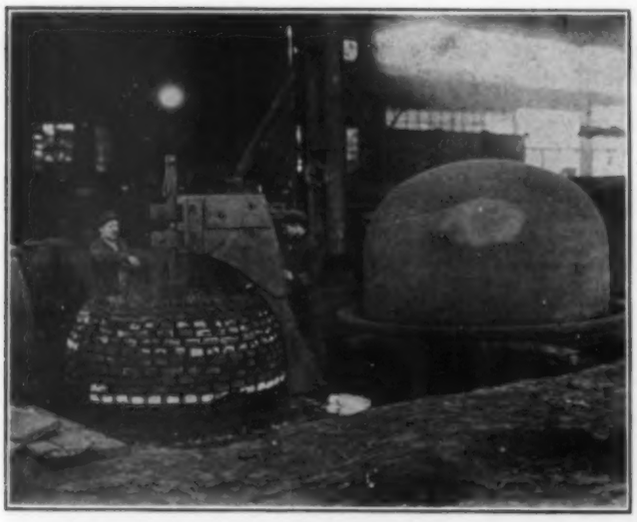
THE addresses and papers of the Spring meeting of the American Chemical Society at Buffalo were followed by exceptionally interesting plant visits. That to the Schoellkopf works of the National Aniline & Chemical Co. should prove an inspiration to the 1100 members in attendance. Though they could have stayed home and perhaps ultimately read in their publications the hundred-odd papers given at the sessions, they never could have received the personal enthusiasm for American chemistry that would have resulted from seeing and then believing in our own industrial efforts.

After being informed that the annual production of dyes in the Schoellkopf plant had been pushed from 2,000,000 to 22,000,000 lb. during the war; the rapid and partial inspection of the works through huge boiler, power and refrigeration plants, and by batteries of mixing machines, autoclaves, filter presses, tanks, stills and condensers, all as compact as extensive, can convey no more than a general impression of the great quantities and types of apparatus used there.

The plant of the Buffalo Foundry & Machine Co. was of especial interest to the industrial chemists on the tour, for here is made Buflokast and Buflovak chemical apparatus. Believing that the attendance represented but a very small part of those keenly interested in seeing chemical apparatus made, we take this opportunity to carry a few views and notes to our readers, in the hope that they will find them of value.

Melting Iron for Casting

Two types of cupolas are used in this foundry. The air furnace is reverberatory and has the advantage that the molten metal does not come into contact with the fuel impurities such as pyrite sulphur. Eight hundred thousand cubic feet of air (64,800 lb.) is used in this furnace per hour, consuming about seven tons of coke and producing 27 tons of molten iron. Since the heat generated by a pound of coke should theoretically melt about 40 lb. of iron, assuming that the combustion and absorption be perfect, it will be seen that an ideal efficiency of only 10 per cent of the heat energy is



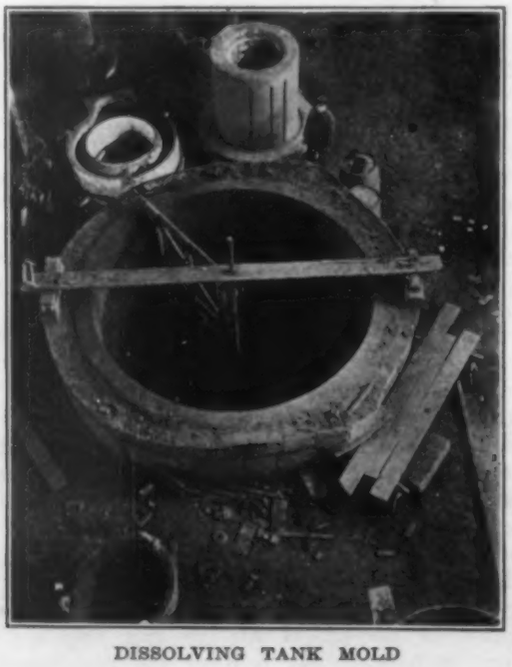
SWEEPING FUSION POT CORES

obtainable. Fluorspar is used as a flux in some cases, and white marble chips in others. A tuyere area equal to 31 pipes of 6-in. diameter is required. Ten inches clearance is allowed between them and the sand floor of the cupola. The other cupolas are of the standard foundry type and have a 15- and 10-ton capacity per hour each.

Making Cores

The characteristic of almost all chemical castings is that they require unusually large cores. Containers holding as much as 400 cu.ft. are ordinary. Both the design and size of the cavity in the casting is obtained by properly suspending and submerging the core. The latter operations are by no means simple. The buoyancy effect of the molten iron, which is about three times heavier than the core material per unit volume, has to be overcome by large iron weights, more than twice as heavy as the submerged core.

The illustration of the fusion pot cores shows the materials and method used in building cores. The center is built up of brick and mortar reinforced with iron rods and ties. Over this a refractory loam is applied and shaped by a revolving sweep, having the center of the core as axis. When the design is finished, the core, which has been built on a car, is run into a drying kiln and fired to remove all moisture. This is very important because water will not only chill the iron too rapidly but gases excessively—expanding about 9000 times in volume. Upon taking the core from the dry kiln, small drying checks are finished over with a special preparation, which imparts a smooth and very refractory finish.



DISSOLVING TANK MOLD

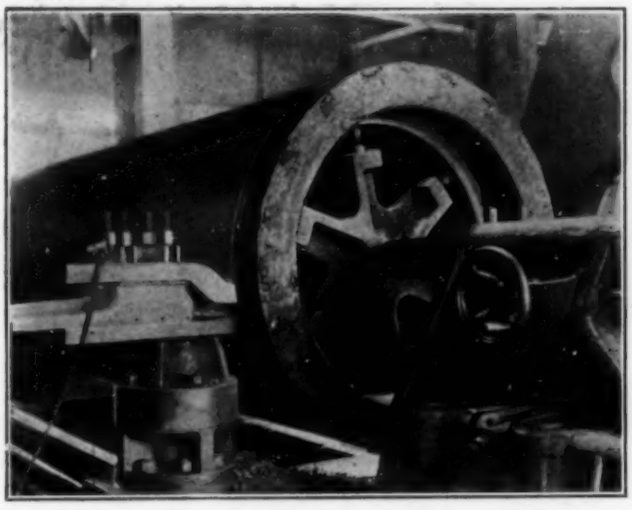
Sweeping Molds

Patterns, sweeps and shaping tools with the skill of the molder are all in need. The illustration shows the mold for a 14-ft. 4-in. dissolving tank in preparation. The sweep for shaping the cylindrical walls and the pattern shaped ribs in the bottom can be seen. The depth of this casting is about 9 ft. As molten iron has a fluid pressure about seven times as great as water, the need for deep pit casting is evident. The ground is well vented with cinder bedding and pipes. The walls of the finished mold are torch baked and finished off similarly to the core surfaces.

POURING A HIGH RISER CASTING

Pouring Castings

After the core has been properly centered and weighted, the ladle is filled with the required amount of metal. The channel for the inflow is connected with the base of the mold and in this way a minimum amount of abrasion of the earth walls is obtained during the pour. The illustration shows a 35-ton ladle being poured with an extra high riser. This is a special feature with these products and makes castings under great liquid-metal head pressure as well as furnishing



MACHINING VACUUM DRUM

large risers in which most of the entrapped sand, gas, etc., is segregated to be removed later. The iron flask rings are lugged together. The small flame shooting from the joints is the gas distilling from the loam, which has been heated to above its kindling point.

The excess metal in the riser is readily removed in a lathe, the operation of which is shown on a drum in an accompanying illustration. In the case of drums, an excess of surfacing material is cast also which is removed at the same mounting on the lathe. In a similar manner, all parts which require perfect lines and surfaces are machined in either a planer or lathe.

The grain of the metal will depend largely on the time of cooling, which will be controlled by the heat of the pour and the time allowed before the casting is stripped. Where a hard and fine grain is desired, the mold is stripped while still at a high heat and the casting air cooled. The core is pulled apart and not taken out whole.

Silicon irons are used where resistance to acids is desired, though time does not permit details to be described here regarding the compositions of each special type of chemical resistant metal. However, special alloys are always prepared under the direct guidance of the metallurgical laboratory to meet the requirements to which the apparatus is to be put in use.

Sizes of Apparatus

As far as the foundry is concerned, there is practically no limit in the size to which castings can be made. Transportation facilities alone govern weights and sizes. For instance, the two dissolving tanks shown on the car weigh but 21 tons each, nevertheless there was only one route out of the several available which had bridge clearance sufficient for them to pass in order that they could reach their destination at Perryville, Md. So 14-ft. clearance can be seen to be the exception rather than the rule. As for weight limits, special six-truck cars are available with well over 100-ton capacity. No single piece of apparatus is likely to stay within the limits set by the car clearances and even approach this weight.

However, industrial chemistry is always demanding larger and larger equipment, and a new method of transportation that is capable of accommodating even the large 400-ton cranes of the foundry has come into vogue. This is by water, through the canal, lake and river route. If the huge ocean liner, the stern half of which is shown on its way to the ocean, only has to be cut in two to meet the water route clearance limit, what chance will the railroads have when really large apparatus is demanded?

Research Laboratories

The research laboratories are composed of two main sections, analytical and mechanical. The first comprises the various chemical laboratories, which are maintained for conducting the analytical work connected with the research department. The second consists of the mechanical testing laboratories containing working units of various apparatus, where practical tests are made on customer's materials to determine the apparatus best adapted to them.

These laboratories are in charge of chemists, metallurgists and experts who are thoroughly experienced in the chemical processes and mechanical operations involved in the use of apparatus.

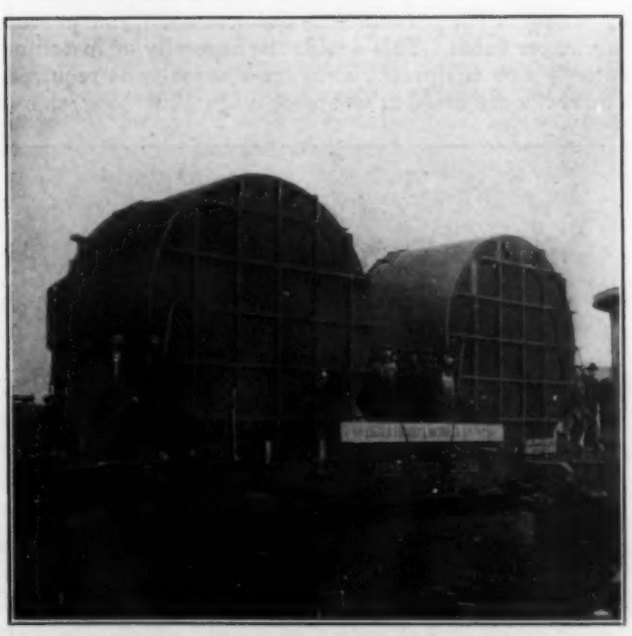
Vacuum Laboratory

The various determinations pertaining to experiments in vacuum drying and evaporating are performed in the vacuum laboratory. Here are also kept complete records of all tests, with samples of some of the materials tested in various stages of the evaporating or drying process. Information and data pertaining to tests are treated in strict confidence and never divulged except to those entitled to them.

Physical Testing and Microphotographic Laboratory

This laboratory is an example of the care and thoroughness observed in manufacture of this type of apparatus. Not only are all raw materials analyzed chemically, but in addition a tensile test is made on samples of all finished products, which are also microscopically examined by means of the microphotographic camera.

The proper metal mixtures and other data required in the production of the castings used in this work are determined in the metallurgical laboratory before the work is taken up in the foundry.



LARGEST TANKS EVER SHIPPED BY RAIL

Another example of the completeness of the laboratory equipment is the laboratory cupola, a part of the metallurgical laboratory equipment. By means of this cupola metallurgists are able to make actual samples of various metal mixtures for testing to determine the mixture best suited for the purpose intended.

A small electric furnace is also in this room for laboratory experiments in electrometallurgy. Work of a larger scope in this field is carried on in the electrometallurgical development department, adjoining the main foundry.

Testing Laboratory

The testing laboratory contains working units of various apparatus, including each standard type of vacuum drier and evaporator, thus making it possible to conduct experiments on each type, if necessary, to determine the one best adapted for the material being treated.

The apparatus used is of small commercial size, and any results obtained can be duplicated, except as to quantity, in the larger sizes.

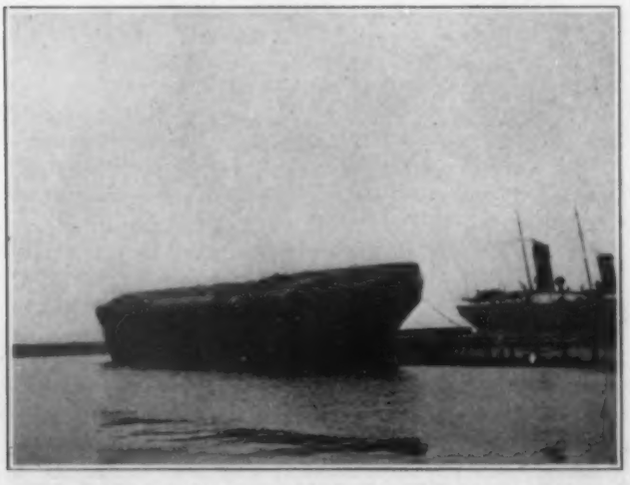
Wet Vacuum Pump. Used for producing ordinary vacuum on evaporators. When a high vacuum is required the evaporators are connected to one of the dry vacuum pumps.

Surface Condenser. Used with evaporators when they are being operated under high vacuum with a dry vacuum pump.

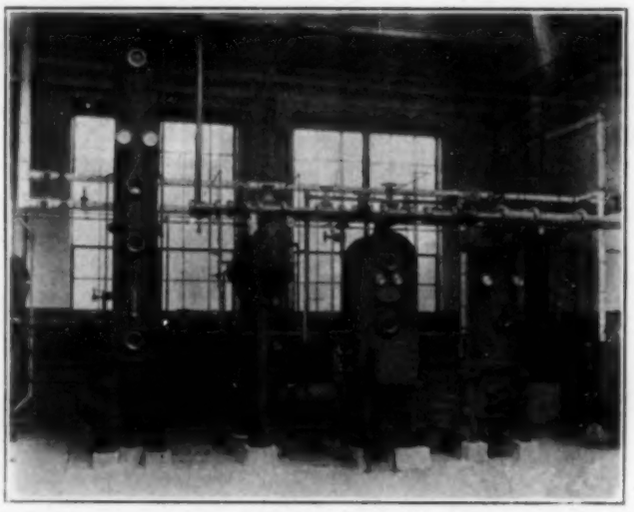
Vertical Tube Evaporator of the Crystallizing Type. Used for evaporating solutions containing salts which become insoluble during the concentration. This small evaporator is equipped with a single filtering device at the bottom, but on larger types two or more salt filters are provided, which can be used alternately without interrupting the operation of the evaporator as each salt filter requires emptying.

Horizontal Tube Evaporator. Used for common solutions which are to be distilled or concentrated to higher densities without the separation of salts, and which have no tendency to foam or produce scale.

In the sizes built for general commercial work the shells are cylindrical. An important advantage of this construction is the possibility of increasing the capacity by simply adding another cylindrical shell and providing longer tubes. This avoids the necessity of installing entirely new equipment when more capacity is required. The shells are made in one piece up to 12 ft. long, thereby reducing to a minimum the number of joints and the chances of leakage.



OCEAN LINER CUT IN TWO BEING CARRIED TO THE SEA



SECTION OF LABORATORY SHOWING HIGH CONCENTRATOR, RAPID CIRCULATION, HORIZONTAL TUBE AND VERTICAL TUBE EVAPORATORS

Rapid Circulation Evaporator. This type is especially adapted for evaporating foamy and delicate liquors. It is economical and capable of high capacities. A special feature of this type is the fact that it can be operated with very small temperature differences, on which account it can be used in multiple effects of many units. This makes for high economy in steam consumption and large capacity of liquor handled.

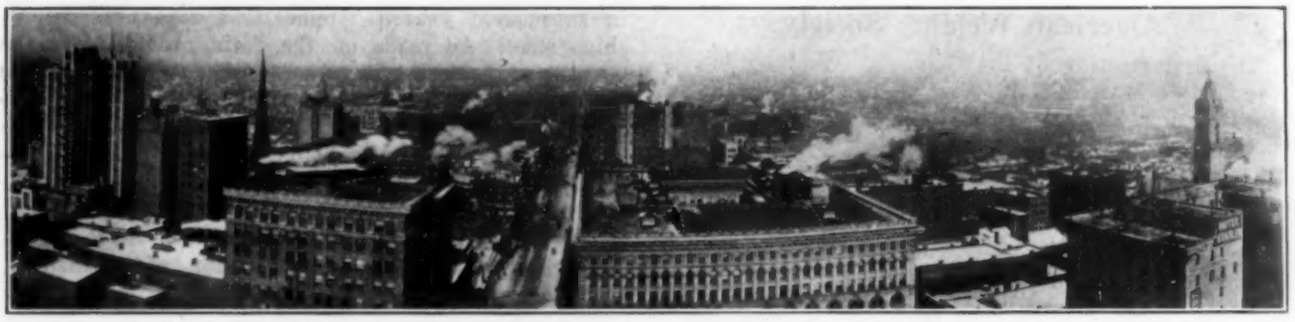
Other features are as follows: High liquor velocity in the tubes, easy cleaning of tubes from the outside, liquor losses on account of foaming or entrainment reduced to a minimum, large capacity per sq.ft. of heating surface, simple operation. It is also noted for its high efficiency, uniform circulation, substantial construction and moderate cost. The amount of liquor in circulation is very small and the possibility of foaming is reduced to a minimum, as the liquor level is always kept low and the foam is broken up in the upper part of the tube where film evaporation takes place.

High Concentrator. Especially adapted for the high concentration of caustic soda, potash, ammonium nitrate and electrolytic caustic solutions above 36 deg. B. This evaporator produces a very rapid, uniform circulation of the liquor and it is possible to concentrate to high densities that are not possible with evaporators of standard construction.

The high concentrator is also used for liquors separating salts, and especially caustic solutions at high densities, where an all-cast iron construction is absolutely necessary. The tubes are made of alkali- or acid-resisting iron depending on the nature of the liquor to be concentrated. The evaporators can be operated under atmospheric pressure or under a vacuum as may be most suitable for the material being handled.

Special Vacuum Drum Drier. For drying pasty substances. This drier is now in the process of development.

Crystallizer. This apparatus can be operated with or without a vacuum. The jacket is cast integral with the pan, this construction being also followed in the larger sizes. This eliminates all joints as well as the use of bolts, packing, etc. This apparatus can be used for concentrating and crystallizing a great variety of products.



Vacuum Rotary Drier. Used for drying materials that permit mixing or agitation. The interior is equipped with mixing arms and paddles attached to a revolving shaft. In larger sizes this shaft is also a heating tube which assists in the drying.

Vacuum Drum Drier. In operation, converting milk from liquid state to dry form. This drier is also used for drying many other liquid materials. Besides being used on experimental work, this machine is also used commercially for drying smaller quantities of material than can be handled economically in the large apparatus. The results obtained on this machine can all be duplicated, except as to the quantity, on the larger sizes.

Laboratory Shelf Drier, Small Size. This is used very extensively in laboratory and research work. Many concerns use it for conducting tests on their own materials and also for determining in advance how deep to load pans for their larger driers. In this drier the center of the stand forms the condenser, and the base a receiving chamber for condensed vapors.

Circulation Pump for Circulating Hot Water. In making drying experiments it is often necessary to use hot water as a heating medium. This pump is connected to all driers for this purpose.

Dry Vacuum Pump. Two-stage, steam-driven. The arrangement of the piping on this and the single-stage is such that either pump can be connected to any piece of apparatus in the testing room, this permitting the operation of any apparatus with a single- or two-stage pump as desired.

Surface Condenser. The surface condensers are connected to all apparatus. They are so arranged that any valuable solvents from materials being dried may be recovered, and also drained from the condensers without interrupting the drying operation.

Expansion Tank. Used in connection with a dry vacuum pump to collect and reclaim highly volatile vapors which sometimes pass through the cylinder of the vacuum pump with the exhaust air from a vacuum apparatus.

Impregnating Apparatus. Used for impregnating any material with liquid compounds, oils, paraffine, colors, etc. Also impregnating electrical apparatus such as coils, armatures, transformers, etc., with insulating compound.

Industrial Research in England

The British Government has placed a fund of a million sterling at the disposal of the Research Department for the purpose of encouraging industrial research. In order that the assistance rendered may be effective in increasing the initiative and independence of the manufacturers, the Advisory Council for Scientific and Industrial Research has recommended that the new fund should be expended on a co-operative basis, in the form of liberal contributions by the Department toward the income raised by voluntary associations of manufacturers established for the purpose of research. That is, if the firms in an industry which are engaged in the production of similar articles, or alternatively, if the firms in different industries which make use of the same or similar raw or semi-manufactured materials, will combine to improve the processes of manufacturing those materials, the Department will contribute liberally to a joint fund for this purpose.

In this manner, a number of research associations may be formed, some treating the problems of a whole industry, while others may limit their activities to a specific branch of a single industry. The expenditure of the fund for each association will be controlled by a committee or board appointed by the firms contributing to the association and the results obtained will be available for the benefit of these firms only. The Government, however, reserves the right of veto in case any proposal is made by a research association to communicate any results of research to a foreign person or to a foreign corporation, and the right, after consultation with the association concerned, of communicating the results of discoveries to other industries for their use on suitable terms. However, no results will be made available to firms or individuals who are eligible for membership in the association in question but have not joined it.

It is hoped and anticipated that these associations, after having received Government assistance during the period of formation, will eventually prove self-supporting and thus make industrial research an integral part of British industry.

Civil Service Examinations

Associate Chemist.—Applications on Form 2118 will be received until further notice. Requirements; Ph. D. degree or equivalent. Entrance salary, $1800 to $2500 a year.

Junior Chemist.—Application on Form 1312 will be received until further notice. Bachelor's degree required. Entrance salary ranges from $1200 to $1440 a year.

Laboratory Aid.—Examinations will be held May 7, June 4 and July 9 at the places designated on Form 1237. Applications must be sent on Form 304. Entrance salary, $840 to $1240 a year.

All of these examinations are open to women as well as men.

American Welding Society

The first meeting of the American Welding Society was held on March 28, 1919, at the Engineering Societies Building, 33 West 39th Street, New York, and the constitution and by-laws were adopted as recommended by the organization committee.

The following officers were elected: President, C. A. Adams, Cambridge, Mass.; vice-president (for 1 year), J. M. Morehead, New York; vice-president (for 2 years), G. L. Brunner, Utica, N. Y.; directors for 1 year, W M. Beard, New York; M. H. Roberts, New York; M. M. Smith, New York; L. D. Lovekin, Philadelphia; Alexander Churchward, New York; W. H. Patterson, Pittsburgh; Walter J. Jones, Philadelphia; C. A. McCune, New York; directors for 2 years, R. R. Browning, New York; A. S. Kinsey, Jersey City; Victor Mauck, Conshohocken; E. L. Hirt, South Bethlehem; J. F. Lincoln, Cleveland; H. M. Hobart, Schenectady; D. C. Alexander, New York; H. R. Swartley, Jr., Jersey City; directors for 3 years, L. H. Davis, New York; E. L. Mills, New York; D. B. Rushmore, Schenectady; James Burke, Erie; D. H. Wilson, Jr., New York; Hermann Lemp, Erie; C. J. Nyquist, Chicago; Alexander Jenkins, Baltimore.

At a meeting of the directors in the afternoon, W. E. Symons was appointed treasurer and H. C. Forbes secretary.

National Research Fellowships in Physics and Chemistry

The National Research Council has been entrusted by the Rockefeller Foundation with the expenditure of an appropriation of $500,000 within a period of five years for promoting fundamental research in physics and chemistry primarily in educational institutions of the United States. A system of National Research fellowships is to be established, under the administration of the Research Fellowship Board of the National Research Council, the members of which are the following:

HENRY A. BUMSTEAD, professor of physics, Yale University; SIMON FLEXNER, director of laboratories, Rockefeller Institution for Medical Research; GEORGE E. HALE, director of Mount Wilson Observatory; ELMER P. KOHLER, professor of chemistry, Harvard University; ROBERT A. MILLIKAN, professor of physics, University of Chicago; ARTHUR A. NOYES, director of the Research Laboratory of Physical Chemistry, Massachusetts Institute of Technology; WILDER D. BANCROFT, professor of physical chemistry, Cornell University.

Fellowship Appointments.—Candidates for Research fellowships will include those who are brought to the attention of the board by professors in educational institutions and by other investigators throughout the country, as well as those who apply on their own initiative. As a rule, fellowships will be awarded to American citizens who have had training equivalent to that represented by the Doctor's degree, but in exceptional cases this requirement may be modified. The salary for the first year is ordinarily $1500, but this, too, may vary in individual cases. The results of all investigations conducted by Research fellows are to be made available to the public without restriction.

Fellowship Applications.—It is expected that fifteen to twenty Research fellowships will be available during the coming year, and that the number will be increased in subsequent years. Applications for these fellowships should be made on the form provided for the purpose, and should be sent to the secretary of the Research Fellowship Board, National Research Council, 1023 Sixteenth Street, Washington, D. C., to whom all other correspondence should also be addressed. Applications will be received up to Sept. 1, 1919, for fellowships available during the next academic year; but a limited number of appointments will be made on the basis of the applications received on or before April 20, 1919.

Imports and Exports

The Bureau of Foreign and Domestic Commerce of the Department of Commerce reports the following imports and exports for January, 1919:

IMPORTS BY COUNTRIES AND EXPORTS (TOTALS ONLY) OF LEAD AND ZINC

IMPORTS

Articles and Countries	Gross Weight Tons	Contents, Lb.	Value
Lead ore:			
Canada	507	113,618	$5,762
Mexico	4,731	639,817	26,776
	5,038	753,435	$32,538
Lead bullion and base bullion:			
Mexico	9,885,902	9,678,891	$611,716
Zinc ore and calcamine:			
Canada	1,042	894,752	14,969
Mexico	1,298	1,034,319	21,216
	2,340	1,929,071	$36,185

FOREIGN EXPORTS (TOTALS)

Lead pigs and bars	.....	5,666,988	$516,057

DOMESTIC EXPORTS (TOTALS)

Lead pigs—Domestic ore	.....	4,658,421	360,457
Lead pigs—Foreign ore	.....	12,875,887	886,130
Zinc spelter—Domestic ore	.....	10,680,934	1,047,990
Zinc spelter—Foreign ore	.....	.....	.....
Zinc in sheets	.....	3,408,051	786,798

IMPORTS OF TIN BARS, BLOCKS, PIGS, ETC., BY COUNTRIES AND CUSTOMS DISTRICTS

Countries	Lb.	Value	Districts	Lb.	Value
England	168,108	$137,491	Buffalo	14,552	$5,576
Canada	14,552	5,576	New York	505,336	377,687
Bolivia	125	75	Pittsburgh	560,000	433,949
Chile	970	421	Maryland	112,079	90,651
Straits Settlements	7,341,240	4,853,302	San Francisco	4,096,202	2,602,732
Japan	56,033	40,923	Washington	2,994,040	1,990,929
Australia	880,416	592,787	Chicago	179,235	129,051
Totals	8,461,444	$5,630,575	Totals	8,461,444	$5,630,575
				Tons	Value
Total imports of tin ore				2,741	$1,862,148

IMPORTS OF TUNGSTEN-BEARING ORE, AND EXPORTS OF TUNGSTEN AND FERROTUNGSTEN METAL, INTO AND FROM THE U. S. BY COUNTRIES

IMPORTS

Countries	Tons	Value	Countries	Tons	Value
Mexico	58	$63,375	Peru	17	$28,050
Argentina	15	26,907	China	270	293,772
Chile	38	43,511	Hongkong	474	456,219
Colombia	1	1,312			
Total				873	$913,146

EXPORTS

Sweden	12,320	$32,000
Canada	2,000	4,340
Total	14,320	$36,340

U. S. EXPORTS OF TIN PLATE, TERNEPLATE AND TAGGERS TIN BY COUNTRIES

Countries	Lb.	Value	Countries	Lb.	Value
France	143,539	$6,298	Ecuador	12,442	$1,372
Greece	541,000	41,450	British Guiana	43,250	5,012
Italy	287,367	22,984	Dutch Guiana	2,140	260
Portugal	448,850	42,500	Paraguay	608,308	44,427
Sweden	18,588	12,910	Peru	502,099	41,157
Canada	9,892,261	772,236	Uruguay	12,821,033	1,020,312
Mexico	963,643	87,259	Venezuela	2,782	135
Trinidad	133	18	China	2,539,913	221,070
Cuba	924,351	96,393	Dutch East Indies	1,672,553	153,418
French West Indies	45,000	5,225	Hongkong	2,668,115	213,195
Argentina	23,357,488	2,243,685	Japan	1,185,637	130,497
Bolivia	153,866	13,454	Australia	1,150	276
Brazil	6,248,288	622,667	Philippine Islands	80,000	11,000
Chile	687,605	83,910	Madagascar	2,500	250
Colombia	564	55	Total	65,854,465	$5,893,425

Effecting and Controlling Crystallization of Ammonium Nitrate

A Description of the Crystallizing Process Employed at the U. S. Ammonium Nitrate Plant—Survey of the Air Conditioning Features Involved and Their Relation to the Entire Process of Refrigeration

BY J. ESTEN BOLLING

THE article on the U. S. Ammonium Nitrate Plant which appeared in the last issue of CHEMICAL & METALLURGICAL ENGINEERING discussed in detail the chemistry of the process employed and included a general description of the mechanical operation of the plant.

It is the writer's purpose to describe at greater length the means employed to effect and control crystallization after the liquor leaves the filter presses, passes through the dilution tank and is delivered to the pipe lines.

The entire crystallizing cycle, from the time the liquor leaves the dilution tank until the crystals are removed from the pans, was considered a unit problem and entrusted to the Carrier Engineering Corporation, of New York City.

The liquor, or solution, leaves the filter presses at a temperature of not less than 64 deg. C., being cooled slightly at the dilution tank, and it was decided to pre-cool it to approximately 38 deg. C. before admitting it to the crystallizing pans. To accomplish this the liquor is pumped from the dilution tank to a pre-cooling room where it is passed through a battery of double-pipe pre-coolers.

COOLING THE LIQUORS

These pre-coolers are constructed of 2-in. pipe within 3-in. pipe, the general construction being similar to that of ordinary ammonia condensers, except that a metal spiral was wound around the 2-in. pipe so as to practically fill the annular space between the two pipes. The pitch of the spiral is about 2.5 ft. and it was added to increase circulation, insure uniform cooling throughout the moving column of liquor, and to prevent the inner 2-in. pipe from sagging at the center and thereby causing a variation in the cross-section of the liquor column exposed to the cooling surface. The pipes are 20 ft. long and could be expected to sag considerably, the smaller internal pipe more than the larger external one.

The liquor is circulated through the annular space between the pipes, the cooling water being passed through the inner 2-in. pipe. This was necessary on account of the relative volumes to he handled.

Two batteries of pre-coolers were installed for each unit of four crystallizing rooms, each battery consisting of 5 regular banks and one spare bank. The connections were designed so that any one bank could be cut out of the system for cleaning, without interfering with the operation of the others. When the liquor is drained out the coils can be flushed clean with water, heated by means provided.

A unique feature of the pre-cooling system is, that in order to avoid over-cooling, it is necessary to raise the temperature of the cooling water *above* that at which it is supplied from the mains. The pre-coolers were therefore arranged for recirculation of cooling water, so that a large percentage of the total volume in circulation is recirculated by independent pumps and the required percentage of cooler water admitted by means of an automatically controlled 3-way valve. It should be noted that the cold water supply varies from 0 deg. C. to 29 deg. C. and that the automatic control was designed to constantly maintain the entrance temperature of the cooling water at a degree high enough to prevent "freezing" in case of a complete cessation of liquor flow.

In addition to the automatic regulation of the cooling water temperature, thermostats were placed in the liquor outlets from each bank of coils, so connected that the flow of cooling water is instantly cut off whenever the temperature of the liquor drops below the danger point. This was considered necessary because the rate of liquor flow through the coils is determined not by the quantity produced in the digestors, but by the flow into the crystallizing pans, and this flow is variable through rather wide limits, being a hand operation. A condition of complete stoppage was not considered impossible.

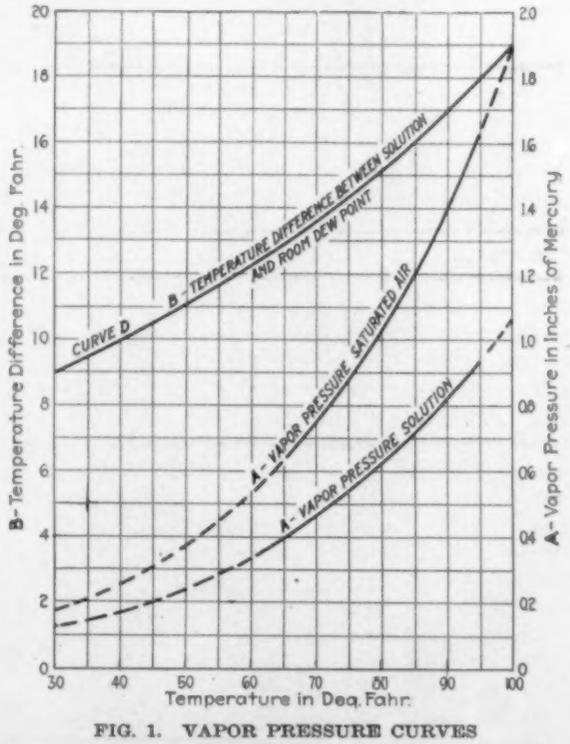


FIG. 1. VAPOR PRESSURE CURVES

The liquor is drawn from the pipe lines into the pans by hand and it is obviously possible for all the pans to be filled at one time so that, for a short period, no liquor would be drawn from the lines. To prevent the freeze which might result under this condition, the liquor feed lines were made in the form of loops which completely encircle the crystallizing rooms. The liquor from the pre-coolers is discharged into an equalizing tank located in the pre-cooler room. From this equalizing tank it is pumped around the loop by independent circulating pumps. These pumps move a volume about twice that which is normally flowing into the pans at any given time, thereby maintaining a constant rapid circulation in the pipe loop. The liquor which has completed the circuit of the loop is returned to the equalizing tank, where it is mixed with pre-cooled liquor from the coils and where an automatically controlled volume of hot liquor, direct from the dilution tank, is admitted to bring the temperature of the entire tank content up to the required degree for safety.

Besides this automatic control of the tank temperature, the liquid level maintained in the tank is governed by a float valve, to prevent overflow. In case the flow into the pans is stopped for a short period the equalizing tank acts as an emergency storage to absorb the fluctuation in flow.

Due to the unusually high temperature of the liquor leaving the filters it is possible to effect nearly two thirds of the total requisite refrigeration in the pre-coolers. The cooling effect of the pre-coolers is equivalent to approximately 1000 tons of refrigeration.

Every precaution was taken to prevent freezing the liquor in the piping system and to this end the design and installation of the entire system was left to the Carrier Engineering Corporation staff of engineers. Dead ends in any part of the piping system were carefully avoided, and means were provided to maintain the liquid temperature in case the flow is stopped, or the system can be immediately drained where necessary, the liquor being stored where crystallization will do no damage.

The saturation temperature of the liquor depends

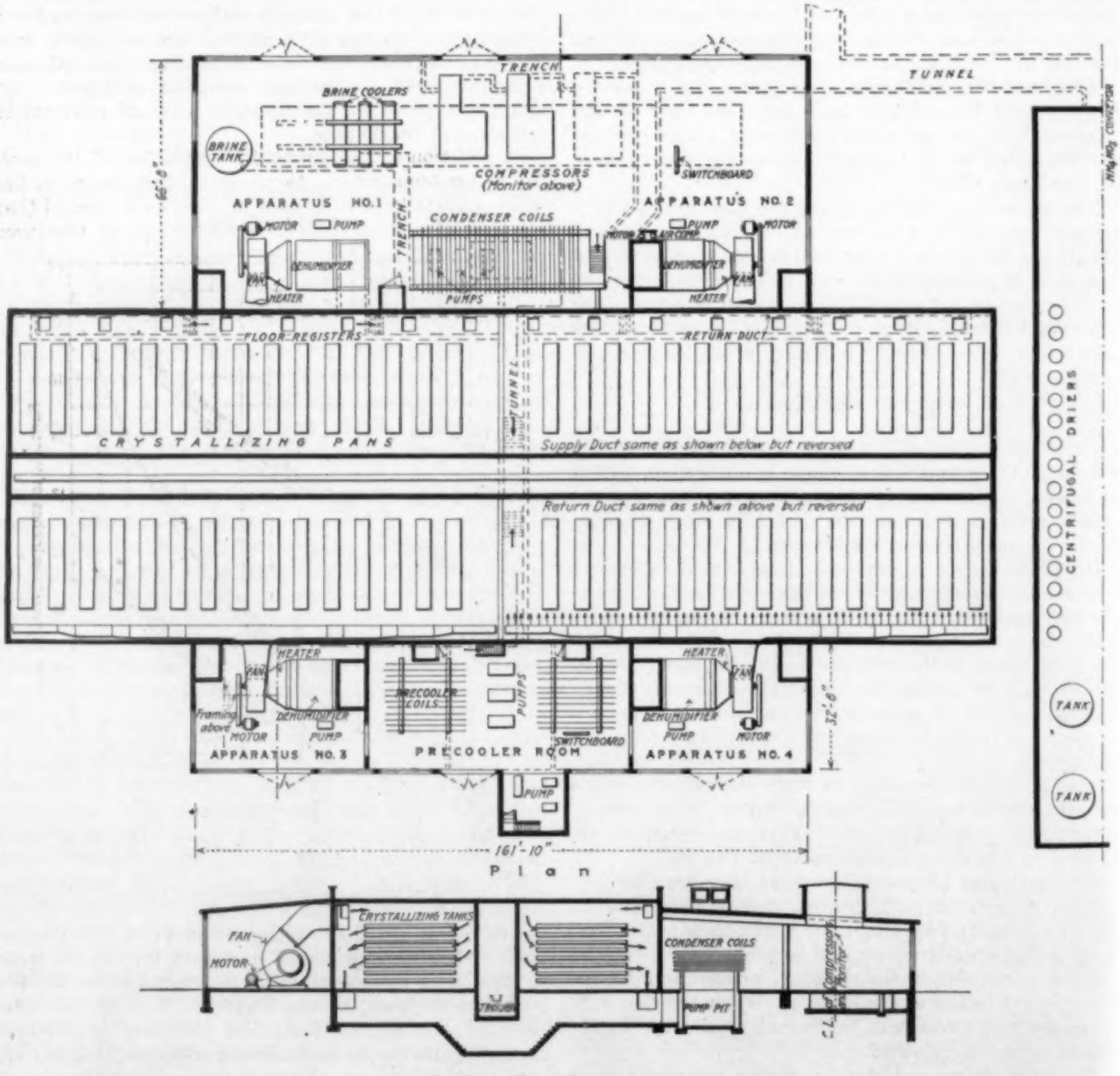


FIG. 2. PLOT PLAN OF APPARATUS

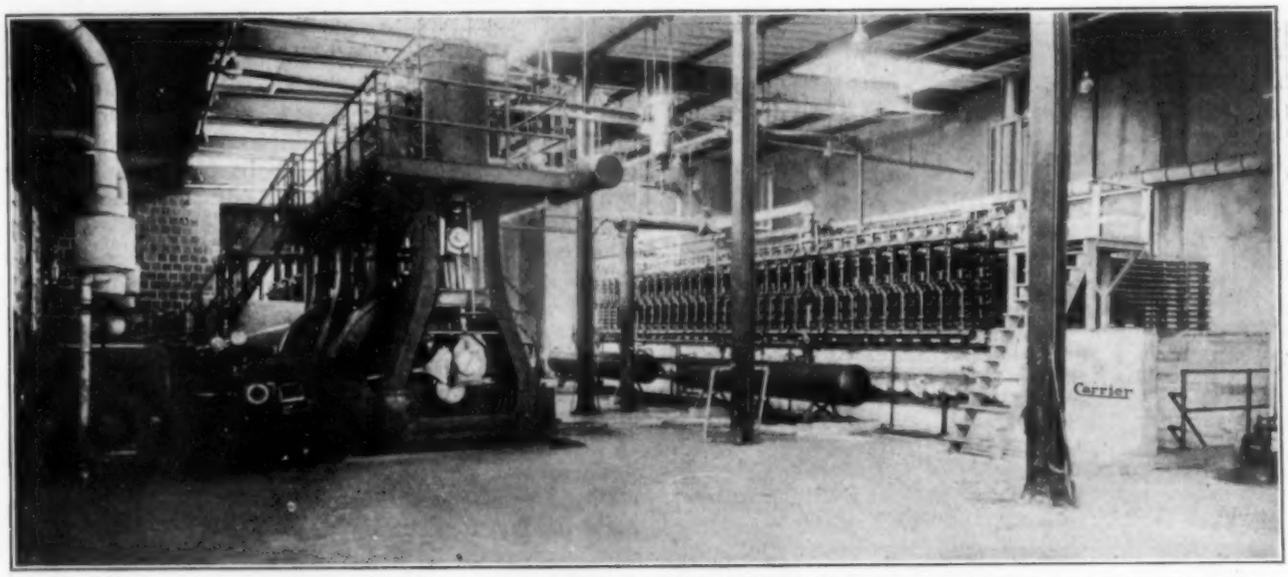


FIG. 3. AMMONIA MACHINES AND BAUDELOT COILS. VERTICAL SINGLE-ACTING COMPRESSORS, STEAM DRIVEN

upon the operation at the dilution tank, and in spite of every precaution it was expected that this would vary considerably. The "safe" temperature was therefore determined for the extreme of this variation and all adjustments made accordingly.

The large pre-cooling coils provide a great excess of hot-liquor radiation in the pre-cooler room and it was therefore necessary to install equipment which would lower the temperature of the room to a permissible degree. Under full operation it is necessary, with the outside temperature at zero F., to introduce cold air in order to keep the room temperature down to 90 deg. F.

For this purpose a small fan was installed and equipped with automatic damper regulation which admits the required volume of cold outside air and recirculates a proportionate volume of air drawn from the room. In summer this fan provides a full volume of outside air, but distributes it uniformly so as to prevent local chilling of the smaller pipe lines or coils, which might be expected if ventilation were obtained through open windows or doors.

Crystallization Department

After pre-cooling the liquor is run into the pans in the crystallizing room.

Due to the very narrow limits between the temperature at which the NH_4NO_3 crystallizes and the temperature at which the other salts begin to crystallize, it is

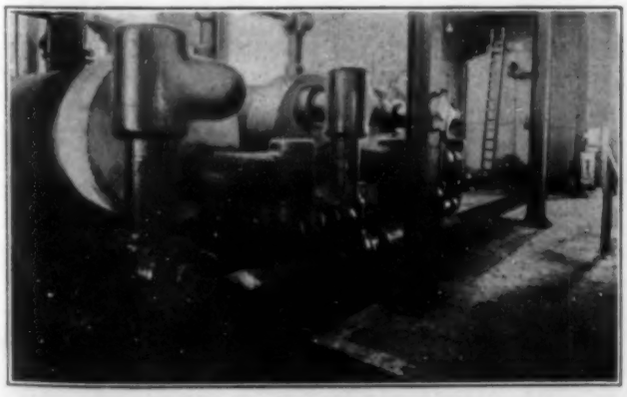


FIG. 4. SHELL AND TUBE BRINE COOLERS

imperative that the cooling be accomplished by the air surrounding the pans, rather than by any form of cooling surface. As pointed out in the previous article, if the filtrate were simply cooled to 20 deg. C. it would be supersaturated with all three salts, NH_4NO_3, $NaNO_3$, and Na_2NO_3, and further fractional crystallization would be necessary in order to separate pure NH_4NO_3. To prevent this sufficient distilled water is added to the filtrate to prevent crystallization of $NaNO_3$ and Na_2SO_4, by lowering their concentration ordinates as is shown in the cycle on page 321.

Desirability of Minimizing Evaporation

In order to maintain this balance, which is carefully determined and effected at the dilution tank, and in order to prevent excessive surface cooling, it is desirable to minimize evaporation from the pans, as far as possible. To avoid evaporation it is necessary to maintain a vapor pressure in the air surrounding the pans, equivalent to or greater than the vapor pressure in the liquor at any given temperature while cooling. To maintain this vapor pressure in the air requires a high humidity, since it requires a correspondingly high dew-point. From the vapor pressure curves in Fig. 1 it appears that the highest vapor pressure in the liquor (at 100 deg. F.) is approximately 1.05 in. Hg, while the dew-point necessary to establish a vapor pressure in the air equivalent to 1.05 in. Hg is approximately 81 deg. F., or 19 deg. F. lower. The ideal crystallizing cycle would, then, contemplate an initial dew-point of, say, 82 deg. F. constantly decreasing along the curve "D," so that the vapor pressure in the air would always be maintained at a value slightly higher than the vapor pressure in the liquor. This would prevent all evaporation and still effect rapid and efficient cooling. To accomplish this it would have been necessary to install a Carrier thermotyme regulator and carefully adjust the instrument for the required control. Although the equipment was designed so that a thermotyme regulator could be later installed, it was decided to begin the operation without complicating matters by installing this instrument, production being of far greater importance than efficiency of operation.

A dew-point of 35 deg. F. was therefore fixed, this

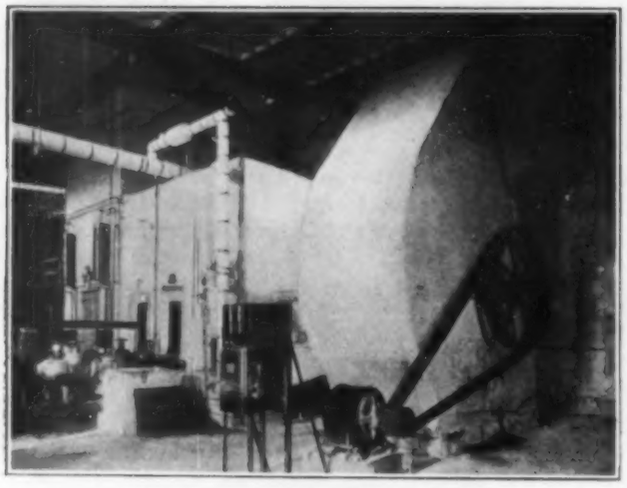


FIG. 5. AIR CONDITIONING UNIT

being low enough to effect rapid cooling and to efficiently utilize salt brine for cooling the air. The dry bulb temperature in the crystallizing rooms was specified at 45 deg. F. (7+ deg. C.) permitting a diffusion of 10 deg. F. This required an air supply of 75,000 cu.ft. per min. to each crystallizing room (or a total of 600,000 cu.ft. per min. for the entire installation), in order to effect the required cooling with the given diffusion (rise in temperature due to heat absorbed from the liquor). To cool the total volume of air to the specified dew-point of 35 deg. F. requires 700 tons of refrigeration.

The crystallizing plant is divided into two main units,

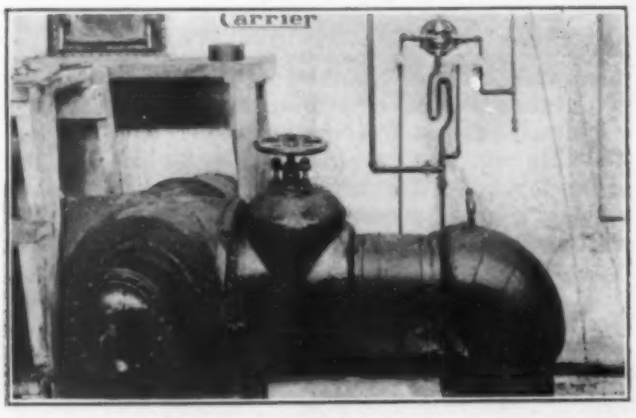


FIG. 6. THREE-WAY VALVE BRINE THERMAL CONTROL

designated as Line A and Line B. Fig. 2 shows a plot plan of one of the crystallizing room units. Since they are exact duplicates this discussion will be confined to a single unit.

Each unit is composed of four separate crystallizing rooms, approximately 36 ft. x 128 ft., each containing 15 tiers of 8 pans each, or a total of 120 pans per room and 480 pans per unit. The volume of each pan is about 40 cu.ft.

The air supply equipment is divided into a separate apparatus for each room, or four complete sets of apparatus per unit.

Refrigeration Equipment

Each unit is supplied with refrigeration from one set of two compressors which supply cold brine to each of the four sets of apparatus. Each compressor set consists of two vertical, single-acting, two-cylinder York ammonia compressors, driven by horizontal Corliss engines (Fig. 3), the machines operating at a suction pressure of about 28 lb. and a head pressure of about 165 lb., and each developing 175 tons of refrigeration, or a total of 350 tons per unit. These machines are cross-connected so that they can be operated as a pair or independently, providing for adjustment of either machine without interfering with the operation of the other.

The compressor sets themselves are also cross-connected with each other so that in event of the complete failure of either set ammonia can be taken from the other unit, as far as available.

Pump-out lines were installed so that any part of the ammonia system can be thoroughly cleansed without affecting the rest of the system.

Three shell-and-tube type coolers, Fig. 4, were installed for cooling the brine. The brine is pumped to each of the four dehumidifiers (Fig. 5), and there

FIG. 7. PHOTOGRAPH OF BUILDINGS SHOWN IN FIG. 2

sprayed into the mist chamber through which the air is drawn in its passage to the fan. The air is thus brought into intimate contact with the finely divided spray of brine and thereby thoroughly cleansed, reduced to the temperature of the brine and completely saturated with water vapor. The temperature of the air leaving the dehumidifier (and hence its humidity, complete saturation being effected) is controlled by means of a thermostat actuated by the air temperature and acting upon a 3-way valve in the brine circulating pump line. This valve (Fig. 6) is so arranged that it governs the relative volume of brine recirculated from the dehumidifier tank (where the spray is collected

FIG. 8. MAIN SUPPLY DUCT, SHOWING EJECTOR NOZZLES

after falling from the nozzles) and the volume of fresh cold brine direct from the coolers. In this manner the temperature of the brine leaving the sprays is accurately controlled.

Since the operation of the control might add sufficient cold brine to the dehumidifier circuit to flood the tank, means were provided whereby a level regulator operates upon the suction of the circulating pump to equalize the volume of brine being removed from the tank and that being added through the automatic 3-way valve. In this manner the liquid levels in the dehumidifier tanks were maintained within a variation of one-quarter inch.

A large brine storage tank was provided wherein the entire volume of brine in the system can be drained while the dehumidifiers and lines are being cleaned. Operation can then be resumed without the delay incident to making up a new charge of brine.

Brine concentration is maintained by the addition of salt and not by evaporation. The concentrator consists of a small tank placed within the large storage tank. This tank is equipped with tangential jets and so valved that part of the recirculated brine can be by-passed into the jets which are arranged to act against a charge of

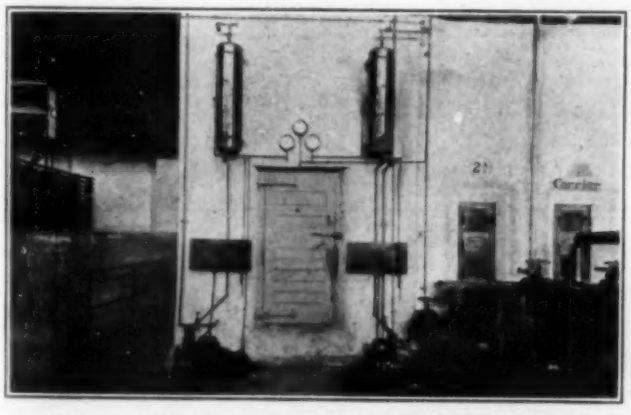


FIG. 9. INLET END OF DEHUMIDIFIER, SHOWING COMPRESSED-AIR CONTROLS

salt. The smaller tank overflows into the larger storage tank, providing a simple and effective means for maintaining concentration.

Three Brine Circulating Pumps

Three brine circulating pumps were installed as shown in Fig. 2. Two of these are used for regular operation, the third being a spare, so connected that it can be used for operating the concentrator when desirable, providing a quick concentration.

The length of the brine supply lines is so great that the movement of a maximum volume at certain times sets up a high frictional resistance which varies, of course, from a maximum to practically zero in proportion to the volume of brine being moved. Such a variation in pipe friction would cause a corresponding variation in delivery pressure at the 3-way valves and seriously impair the accuracy of the control. To obviate this variation a special pressure regulator, built by the Taylor Instrument Companies, was installed in the lines, and regulates the delivery pressure at the 3-way control valves between 18 in. and 20 in., with great accuracy.

The thermostatic control which actuates the 3-way brine mixing valve is in operation during the summer season only. Whenever the atmospheric temperature is low enough to provide the necessary cooling, the compressors are shut down and this control is adjusted to operate 3-way mixing dampers, recirculating part of the air from the room, adding the requisite volume of cold air from the outside, and affording a relief for an equal volume through a vertical exhaust tower (Fig. 7). In the summer these dampers are disconnected entirely and the openings closed with heavy tight-fitting doors.

The roofs of the crystallizing rooms are surrounded with a water-tight concrete wall about 10 in. above the roof level. The basin thus formed is filled with water to a depth of about 8 in. The evaporation of this water, in the summer season, absorbs the greater part of the direct sun heat and greatly decreases the loss by radiation.

Air Conditioning

After the air has been conditioned in the dehumidifier it is drawn into large Buffalo Conoidal fans and blown into the crystallizing rooms. The accuracy and sensitiveness of the controls is of little value unless the air distribution within the rooms is uniform and positive. Distribution is effected by means of the Carrier Ejector System, shown in Fig. 8. The circulation is indicated by the arrows in the elevation shown in Fig. 2. The fans discharge into the main trunk duct. From this duct, at regular intervals, nozzles project at right angles. These nozzles are so arranged that the kinetic energy of the high-velocity jet of air is utilized to set up a suction or "ejector effect" which causes a large percentage of the room air to be drawn into circulation. Thus the actual movement of air *within the room* is many times the volume handled by the fans. The path of the circulation, as indicated by the arrows, is across the top of the room, back through the pans, and out through the return duct, which is placed beneath the floor directly under the supply duct, as shown.

This system insures absolutely uniform distribution, and effective and positive velocity, minimum consumption of power at the fans, and enables an apparatus of small capacity to perform work usually requiring much larger, and correspondingly more expensive, equipment.

Accurate Control of Temperature and Humidity of Air of Great Importance

It is essential that the temperature and humidity of the air be controlled with the greatest accuracy, as a drop of a few degrees will begin to crystallize the undesirable sodium salts. From the first day of operation the control was so accurate that no difficulty whatsoever was experienced in holding the variation within a negligible range. All of the thermostatic controls employed act by the expanding and contracting effect of temperature on metal, which effect is utilized to operate a small air valve. The movement of this valve admits or releases an air pressure of approximately 15 lb. per sq.in. which acts upon diaphragm valves or diaphragm motors as required. Fig. 9 shows two of the control panels with small belt-driven air-cooled compressors for maintaining the compression.

It should be remarked that this installation is particularly significant because it again demonstrates the practicability of air conditioning apparatus on a large scale, where dehumidification requires mechanical refrigeration, and where immense areas must be controlled with a precision equal to that of the finest laboratory processes.

New York City.

CONTACT SULPHURIC ACID PLANT, AREA B.

Erection of Huge Sulphuric, Nitric, Mixed Acid and Denitrating Plant Under War Pressure

Construction of One of the Largest Acid Plants in the Country, Under Adverse Conditions—A View of the Situation in General With Methods of Construction

BY H. E. AND C. E. HOLLISTER

THE construction of one of the largest acid plants of its kind in this country and possibly in the world was started on a river bottom farm, still covered with corn stubble, in March, 1918. The weather was bad—cold and extremely rainy. For a month the sunshine was a rare sight. The frost had just left the ground and a wagon buried to its body was a common sight. A bull team, although perhaps considered by many as out of keeping with modern construction, was a valuable asset and the only certain method of transportation. Corduroy roads had to be built for trucking, plank runways for handling material in wheelbarrows and hand carts, but with all handicaps the wheels were started on an arranged schedule, with a fixed goal, and except for modifications made to suit uncontrollable conditions due to other war requirements of the country, they continued to turn as desired throughout the job.

ACID PLANT

The acid plant was a portion of an explosives plant being built for the Government. The trouble in one part was common to the others and all work had to be co-ordinated to avoid undue confusion.

The acid plant covered roughly 110 acres and formed rather a triangular shaped plot, as seen on the general outline plan. The east side was bounded by the main line railroad tracks and a portion of the sorting yard, the west side by the river, while the other sides were boundaries of other areas of the explosives plant. (See Fig. 1 showing general layout of plant. Buildings shown in solid were required first. Each unit as numbered was a complete process in itself and put in operation in succession.)

The contact (sulphuric acid) plant consisted of seven units with capacity of 560 tons of oleum per day, with sulphur storage, building and apparatus for preparing platinum mass, acid storage tanks, etc.

The nitric acid and mixed acid plant consisted of four units with an available capacity of 720 tons per day, with a working storage to hold 20,000 tons of nitrate of soda, and an emergency storage for a surplus of 15,000 tons, also bag washing buildings, storage buildings, etc. The acid mixing plant was arranged to take care of the full output of the nitric plant, with a 30 per cent excess for emergencies. There were offices, service buildings, machine shops, compressor houses, fuel storage and other accessories erected for use of both plants.

In addition to the nitric and sulphuric acid plants, there was erected a denitrating and concentrating plant to handle 480 tons of spent acid from a cotton nitration plant, the concentrated sulphuric being returned to the nitric plant for charging retorts, and the nitric remixed at the denitrating plant with oleum to produce mixed acid.

These figures will give some idea of the size of the plant, but as a matter of comparison it is fair to say that before the war a 10-ton oleum unit was an average size. A fair size plant might have four of these units. This oleum plant had twenty-eight 20-ton units. Ten 6000-lb. nitric retorts were considered a fair sized nitric plant at one time, a few explosives plants possibly having as many as twenty. This plant contained ninety-six retorts arranged for a 7500-lb. charge and could, if the emergency had arisen, have handled an 8000-lb. charge.

The whole plant was much more extensive than any previous construction of similar nature. There were those plants which by slow degrees had grown to great proportions, but even in these there was no group of this size more diversified.

There were many handicaps, which were to be expected on a piece of work of this magnitude, also many which were not expected in advance. Large quantities of material were required, which had to be obtained from sources already crowded with orders, and shipped over congested railroads. Special apparatus had to be built and, due to its nature, could only be obtained from a limited number of manufacturers. Although the plant covered a vast area, storage space was limited, and the receiving and handling of materials had to be closely watched to avoid congestion. Labor and specialized mechanics, that should have been plentiful on a Government proposition at that time, were conspicuous by their absence.

The plans were started in New York and outlined enough for preliminary listing of materials, and purchasing was started. Arrangements were made for delivery of materials on certain dates to correspond as nearly as possible with schedules of construction.

Systems of listing on material bills and item lists were adopted and various parts given mark numbers which were used to distinguish them throughout the preliminary work and for use during construction. Considerable work was done to standardize and simplify the apparatus and buildings for the purpose of ease of construction, economy of materials and to expedite erection. It was necessary in many cases to make changes in design to suit the standards of manufacturers or to make it possible for certain shops to utilize materials in stock. This, of course, cheapened the work and greatly assisted in delivery of finished apparatus. After designing work had reached a proper point and purchasing had progressed to such an extent that the program of delivery was assured, the construction work was started.

Purchasing

A special department, working in conjunction with the agents for the Government and the director's staff, handled the purchasing for these areas. The engineers and technical advisers, with the advice and assistance of the War Department officers, settled questions of quality and type of apparatus or parts.

An attempt was made to have details prepared and orders placed in advance for materials which would require considerable time for completion, so that all parts would come in as required. Orders were placed on basis of price, quality and delivery, and in some cases prices obtained, especially in castings, were on a par with those made to private industries before the war and high prices of pig iron. It was necessary to be reasonably assured before placing an order that the company was in a position to make the deliveries, and had or was in position to obtain the required raw materials without assistance. With few exceptions, the materials and apparatus were delivered as required.

The preliminary work on all the plant was started as soon as conditions due to the severe winter weather permitted, and actual building of the plant began as soon as the needed material arrived. A temporary spur about a hundred yards from the right of way had been laid and a drive was started for one of the permanent tracks

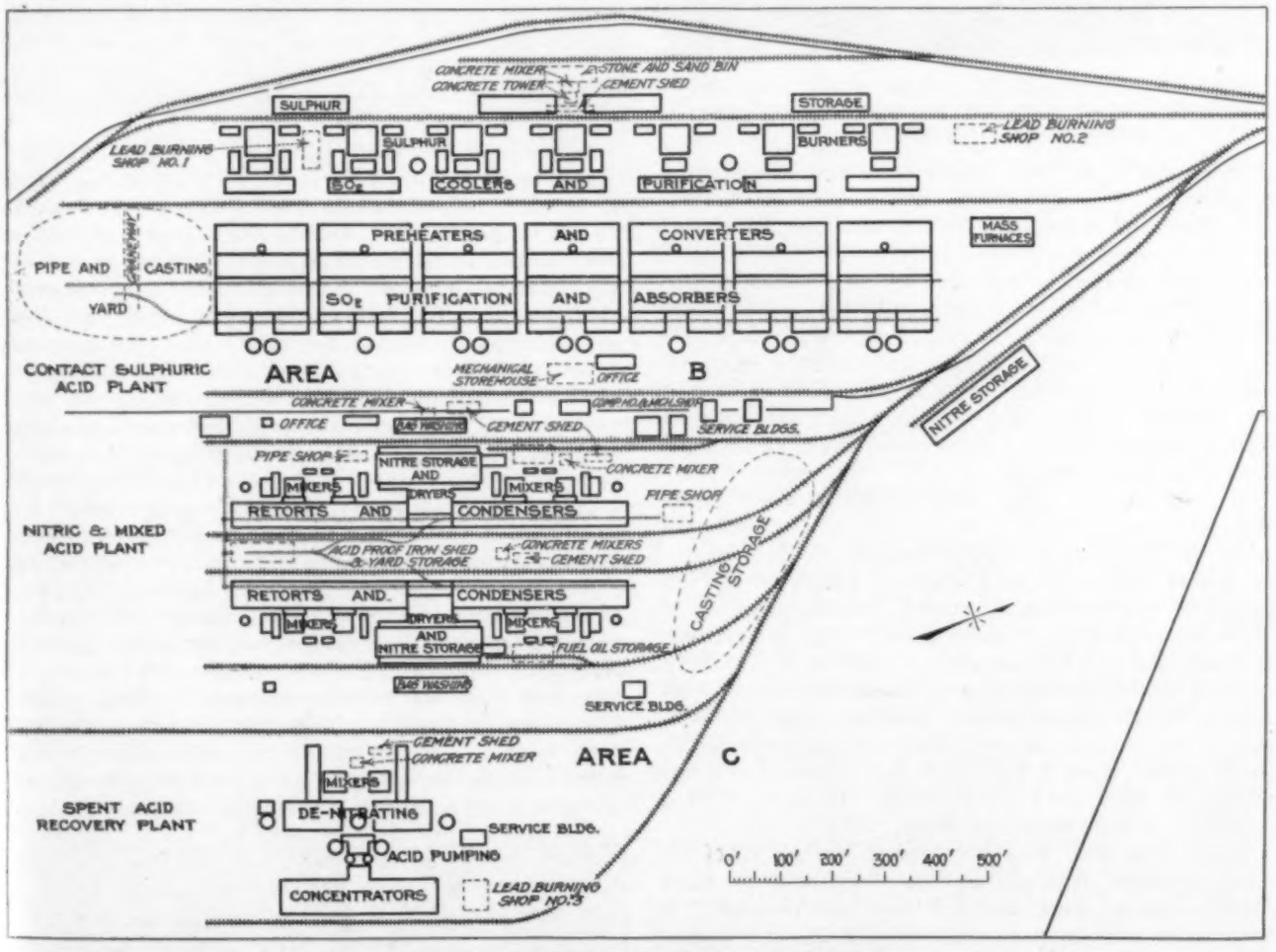


FIG. 1. GENERAL LAYOUT OF THE PLANT

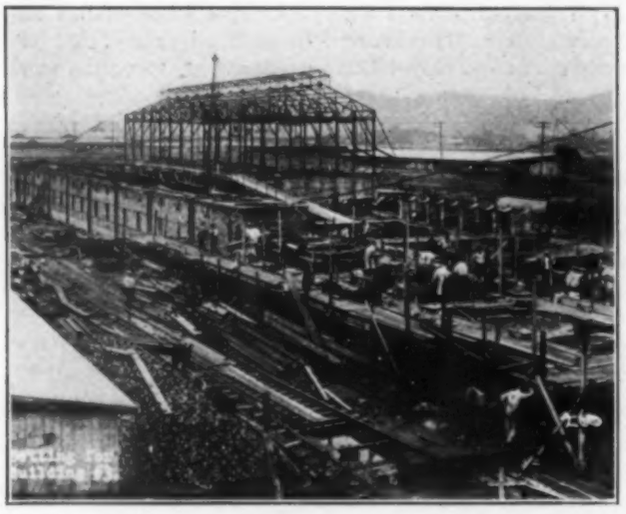


FIG. 2. UNIT 3, AREA C. STEEL WORK OF NITER STOREHOUSE AND RETORT SETTINGS UNDER CONSTRUCTION

through the area. The others were laid as the work progressed.

Lumber and other materials already available were utilized to erect warehouses for construction purposes, offices were erected, which remained as permanent operating offices, but during construction were used for the field office force and draftsmen. Temporary roads, runways, etc., were built and general preparation made for the real construction of the plant. The first excavation was started by hand, and later on steam shovels were utilized where possible. Some forms were also started for the concrete footings.

A large concrete plant with cement storage houses, bins for sand and gravel, and a tower were erected in Area B. This was to supply concrete to Units 2 to 6 by chutes and to the other units by means of concrete buggies. The preliminary starting and early stages of the work were greatly handicapped by the uncertainty of labor, delays in the delivery of some of the construction equipment, and many other annoyances beyond the control of the organization. Housing conditions were at that time insufficient, which caused discontent among the workmen, made worse by the cold weather and rain which fell daily for quite a period. In spite of these conditions a good start was made.

Excavating was done with steam shovels and drag scrapers where possible, and the remainder by hand. Trench diggers were used for pipe line trenches. In most places scrapers were used for back filling in connection with some hand work. In Area B the first unit was excavated mostly by hand, but in other units the greater part was steam shovel work. In this area it was necessary to use dirt excavated from the first four units for building up the grade of the three other units, the ground being highest at the northeast side and sloping toward the southwest.

In Area C footings were excavated through mud in the low ground at Unit 3, and while these were being concreted, scrapers were used to grade land between the two units, the dirt being used as fill west of the unit. After completion of concrete footings, material excavated by steam shovels and scrapers from Unit 1 was used to bring Unit 3 to grade. Excavated material from Unit 2 was also used for back filling in and around Unit 4.

The spent acid plant was on fairly level ground, practically the only excavation being done for the footings. This gave about enough fill for the low spots around the buildings. All the material excavated could be used within a reasonable distance of the point from which it was taken and it was either put in place as excavated, or piled out of the way for distribution later. This was fortunate, as lack of roads made haulage almost impossible. As excavation progressed it was immediately followed by concrete work, which in turn was closely followed by construction of buildings and apparatus.

Concrete Work

Most of the footings were mass concrete. Reinforced concrete was required for some of the walls of buildings and apparatus supports and for storage bins, bag wash houses and trench slabs. Forms were constructed of lumber and made into permanent panels or collapsible forms whenever possible. As many of the footings were duplicates, this saved labor and material and greatly expedited the work.

As many of the walls were high and as it was desirable to fill the whole form at one pouring, the form work had to be well done and carefully tied and braced. No oil or grease was used on forms, but very satisfactory results and a smooth surface were obtained by using finished lumber, and working the concrete well while pouring. Due to the shortage of form lumber, it was sometimes necessary to remove them the morning following the pouring, but care was taken to prevent loading or side pressure from fill to come on the concrete until it was well seasoned, thereby avoiding any injurious results. In most cases after the first units of both Areas B and C were under way, concrete floors were poured at about the same time as footings. By doing this it was not necessary to keep mixers tied up, so preventing interference with other construction. After concrete work in a particular building was completed, the equipment was then available for use elsewhere, and was either used at another point on these areas or turned over to contractors on other areas.

In Area B the first concrete was mixed in small mixers and placed by hand, but later the concrete tower was put into operation and the concrete either shot directly into forms or into hoppers, from which point it was conveyed to the desired locations by buggies. A spur

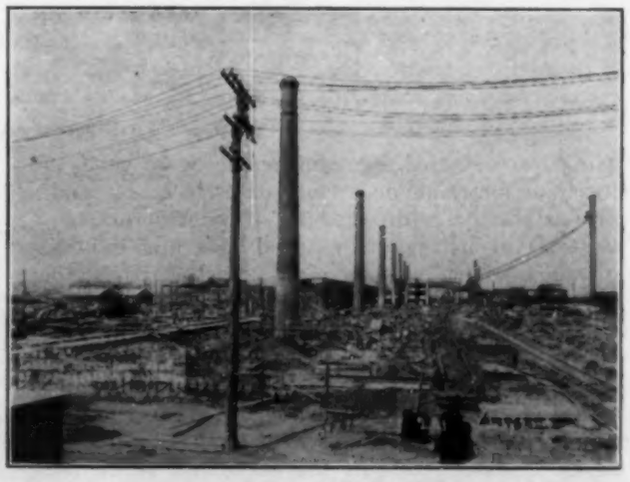


FIG. 3. COMPLETED STACKS FOR SEVEN H_2SO_4 PLANTS OF WHICH NO. 4 IS UNDER CONSTRUCTION IN THE VIEW

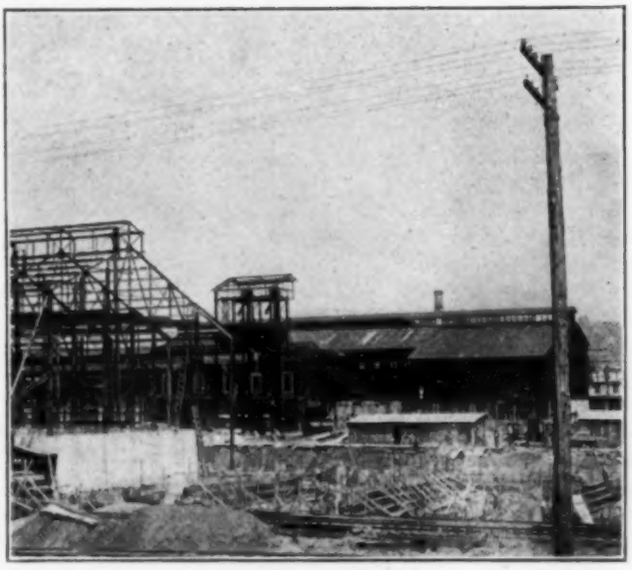


FIG. 4. ELEVATORS, BINS AND DRIERS IN COURSE OF CONSTRUCTION

track was built directly alongside of the material bins as shown in Fig. 2 and material unloaded and delivered to bins by a stiff-leg derrick fitted out with a clamshell bucket. The flow of material from bins to mixer was by gravity. Due to the congestion of buildings and lack of unloading space, the concrete tower was extremely useful and accomplished the desired results. The variation of material and substitution made for sand and stone caused annoyances at the start of the work, but these were overcome as soon as the crew became experienced in handling them. For special mixtures or out of the way places, portable mixers were used.

On Area C the arrangement of buildings made a tower impractical. Austin cube mixers of one-half yard capacity equipped with a self-loading device, filling at ground level, were used. The mixers were cribbed up to such heights that discharge hoppers emptied into a receiving hopper or concrete buggies, and these buggies were pushed along runways above forms. Where possible, mixers were placed alongside of railroad tracks and material used with one handling.

Runways were built up and cleated into sections so that they could be cheaply and quickly changed to any location. These sections were used throughout the job either in elevated positions or on the ground.

Reinforcing rods were cut, bent and otherwise prepared in advance of the concrete work, and were carefully bundled and marked in readiness for use. The steel for the storehouses was prepared in such manner that a section of the building could be assembled in one day. These sections were 50 ft. square and 14 ft. high. Work on the first unit of both Areas B and C was somewhat slow at the start, but rapid progress was made on other units where it was possible to use the forms and standardize the work. The crews were also more familiar with the work than in the beginning.

General Erection

Buildings were constructed with timber, steel and concrete frames, the filling walls being of corrugated asbestos-covered metal, wood covered with roofing paper and battens, tile walls, brick walls and novelty siding. Roofs were of corrugated asbestos-covered metal, wood or cement slabs, with tar and gravel covering. The various illustrations show the types quite plainly. There was considerable delay caused by lack of steel work, its slow delivery being due to manufacturing and transportation conditions throughout the country. Lumber at times ran low, but this construction was most flexible and substitutions could be made which prevented any serious hold-ups of the work. When held up for steel, apparatus was often erected in advance of building. When shortage of any particular materials did occur, the men were immediately shifted to other parts of the job, so that at times work had been started and partly completed at several points. The object was, however, to complete the work in units, as certain buildings were required first to start manufacture. These were indicated and called for in the original schedules and were as shown in Fig. 1. To obtain the greatest efficiency from available workmen, shifting was of course necessary, but they were returned as quickly as possible to the buildings being pushed to completion.

Construction of one unit after another was started in such a manner that the mechanics moved successively from one group to another. This meant that after the first unit was complete and in operation, the successive units were ready at regular periods. Fig. 3 illustrates fairly well units at various stages of completion, each stack being in the center of a unit.

The steel work of the buildings was in many cases also part of the apparatus. It was not always possible or desirable to distinguish between the two for erection purposes. Millwrights, machinists and apparatus erectors were intermingled with other mechanics when and where necessary to properly erect the work, and the work was so laid out and supervised that no confusion resulted. This intermingling of men of various trades required at times considerable tact to keep peace in the family.

Upon completion of the building frame work, and in most cases before the buildings were closed in, erection of apparatus was started. The apparatus in many cases was ready for operation about the same time the buildings were finished. In Fig. 4, center, can be seen elevators, bins and driers in process of erection while building is under way, an example of this type of construction.

The building frame work was simplified as much as possible so as to utilize standard shapes. The steel buildings were fortunately so located that a locomotive crane could be used for placing the steel, in both areas, from railroad tracks. This greatly facilitated erection, especially where it could be unloaded and put directly

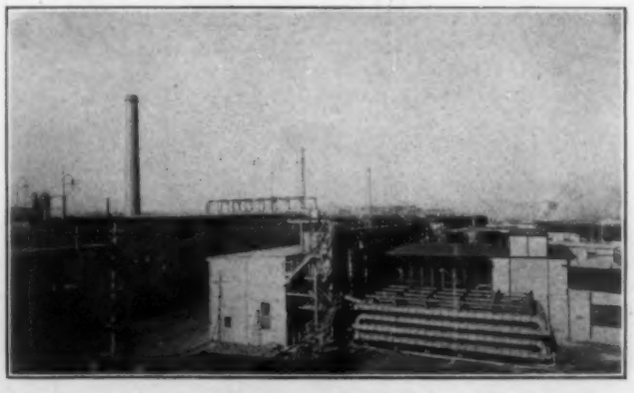


FIG. 5. SULPHUR BURNER BUILDING. SO_2 COOLERS IN FOREGROUND

in place. A narrow-gage track was run from the brick and tile stock piles to buildings under construction and cars either pushed by hand or hauled by an electric storage battery tractor were used to handle the materials. These tracks show in several of the illustrations. Lumber was delivered by cars to the nearest point and distributed by teams.

Apparatus Construction and Erection—Pipe Work

In acid plant work only a small amount of the apparatus can be purchased complete and ready for erection. Most of it consists of material in a partly finished form ready to be built in with other parts to form a certain piece of completed apparatus. Considerable of the apparatus was constructed of masonry with a large amount of lead work, pipe of various kinds and steel work. Mechanics of all kinds were required, and due to the very large scale on which everything was done, it was necessary to train men for many purposes.

Millwrights and machinists were necessary to assemble and erect machines and apparatus which came completed, as well as the building of special apparatus, either by themselves or with other mechanics. Several hundred pipe fitters were required, some on steel and wrought iron piping, which was both flanged and screwed, for handling steam, air, water, acid, oil and other materials. Others were on cast iron pipes which varied in size from two inches to twenty-four inches. These were both flanged and bell and spigot, used to carry illuminating gases, acid gases, acids and water, etc. There was also considerable special pipe and special acid resisting pipe required to handle nitric acid, also brass, glass and special steel pipe.

A pipe yard was located at the north end of Area B. This was the only available open space. Two narrow-gage tracks ran the full length of the sulphuric acid buildings from this yard, and flat cars hauled by electric tractors delivered the material when required. A small overhead craneway with traveling cranes, part of the permanent equipment borrowed from the acid plant, made it possible to reload heavy pipes on the flat cars with little labor. A locomotive crane unloaded the incoming freight cars and placed material in storage piles, as desired. As the freight cars arrived with mostly fixed loads and sometimes with parts not required for immediate use, this method of handling was found very efficient.

At the nitric and spent acid plants in Area C steel

FIG. 6. CONSTRUCTION BUILDINGS. MASS HOUSE TO THE LEFT

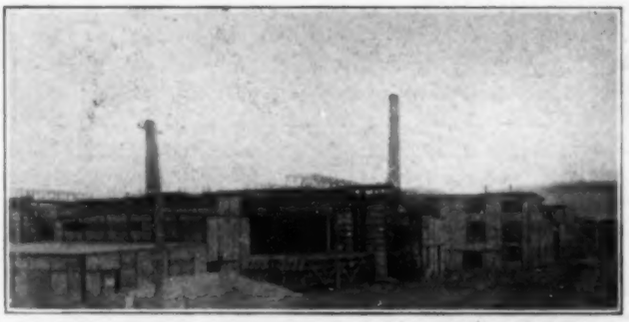


FIG. 7. VIEW OF SULPHURIC ACID UNIT

pipe was unloaded for storage as close to the pipe shops as possible. Heavy pipe was delivered direct by locomotive crane to the trenches or places in which it was to be used. Acid-proof iron was included as apparatus and placed in special warehouses.

Lead Work

Lead piping, of which there was a great amount (a good example of which is shown in Fig. 5), was all handled by a crew of about seventy lead burners. Large lead pipes, ells and other fittings were prepared and made up in the lead shops, with all other work which could be handled at this point, leaving the final assembly only for field work. In this way it was possible to utilize the men regardless of weather. The system of narrow-gage tracks made delivery of heavy and bulky parts to their final location an easy matter. The sheet lead as it arrived in carloads was sorted by a locomotive crane and delivered to the proper lead shops. Hydrogen for the burners was both purchased in cylinders and manufactured from spelter and acid on the job. The cylinders were used mostly for assembling lead work in place, as it was more handy and cleaner. Each lead shop was equipped with a very large capacity generator.

The lead burning shops 1 and 3, each located at the most central points, both as to delivery of finished material and railroad facilities, as the handling of the raw materials, as shown by figures given later, was no small part of the job. Lead shop 2, with its storage, scrap melting shed, etc., is seen in the foreground of Fig. 6.

Castings and Apparatus

The heavy castings and parts of apparatus to be erected also required much attention and forethought in handling. A portion of the pipe yard was used for heavy castings and parts of apparatus. The same cranes and industrial cars handled this material. All materials were reinspected before erection, and by the use of the overhead cranes, parts could be handled, sorted and stacked as desired. In this way there was no confusion and a check of stock on hand could be made very quickly.

Tanks were taken from cars and placed directly on foundations as often as possible, with the exception of those to be erected in place. In this case the sheets were taken from cars by cranes and placed as near the permanent location as conditions would permit. As most of the tanks were behind schedule in delivery, all footings were completed in ample time and this portion of the program worked out very successfully.

At Area C, especially in the nitric acid plant, there were many heavy castings. The retorts weighed about

FIG. 8. NITRIC ACID RETORT AND CONDENSER BUILDINGS

eleven tons each. As these came in shipments of two or three, and as it was found more convenient to place them in their settings with a powerful locomotive crane which had to be borrowed, they were accumulated until twenty-four were on hand. The castings as they arrived were unloaded by the regular cranes along the spurs at the south end of the unit and rehandled when enough were on hand. Twenty-four of these retorts as well as their tops could be put in place in six hours. Small castings were sorted, inspected and placed between Units 2 and 4 and taken to location as required by industrial cars.

A warehouse fitted with shelves and bins was erected between Units 1 and 3 at the north end, as shown in the foreground of Fig. 8, where it could be served by two railroad tracks and have wagon delivery. This building was used for the storage of special acid-resisting iron pipe, castings and glass. This material is very brittle and must be handled like glass or porcelain ware. All pieces had to be reinspected upon unloading before being put in stock, as breakage and damage during shipment run high. The warehouse was provided with an industrial track its full length, this track branching out into the four units of the nitric plant. Material was loaded on flat cars as required and distributed. There was practically no breakage of this material after it arrived on the ground, which was considered quite a feat, as in ordinary practice this loss runs very high.

The greater part of the castings for the spent acid plant were unloaded from the cars and delivered by the locomotive crane almost at their destination. Due to the compact formation and nearness of main railroad tracks, an industrial track system was not used. In the other areas they were indispensable and saved much time, labor and trouble.

The apparatus was assembled and erected inside of the buildings by chain blocks and hand derricks. In some parts of the sulphuric and spent acid plants, where continuous replacement of heavy castings is necessary during operation for the purpose of cleaning or replacing apparatus, permanent craneways were erected. These were used for erection purposes during the period of construction.

Mason Work

A great amount of the work, as is usual in acid plants, consisted of masonry. This also varied from common wall and fire-brick settings to acid-tight masonry. Even the acid-proof masonry consisted of various grades of acid-proof brick laid in a number of mixtures of acid-proof cement to suit the various conditions. Fire brick was also of several qualities to meet the heat requirements. Brick work in plants of this nature must be

FIG. 9. TOWER AND PREHEATER BUILDINGS. BRIDGES CARRY LEAD SO_2 LINES

FIG. 10. NITRIC AND SPENT ACID PLANTS

properly and carefully constructed. The life of the plant and economy of operation in many cases depend on the proper carrying out of this end of the work. Many masons are not suited and others without the proper experience must be trained for their particular work. Where possible and practical, mortar was mixed in small concrete mixers, the large number of masons and extent of work making this an economical method. Where parts of the building or other apparatus were built into the masonry, various mechanics worked together or shifted their work to accommodate one another.

Inclines were constructed, operated by gasoline hoists, equipped with narrow gage cars to supply material to towers and other high places. One is shown in center of Fig. 6 at the left of locomotive crane. These were so arranged that a number of towers could be fed from the same incline. Fig 7 is a view of one unit of the sulphuric plant looking west. The nitric and spent acid plant is in the distance. The river is to the foot of the hill in the background, almost half a mile from the camera. Fig. 9 shows a view looking south between the sulphuric buildings. The building to the right, containing furnaces, had to be of steel. The small one at the left is timber, that to the far left is of steel and houses the sulphur burners.

Fig. 10 shows a view of one end of the nitric acid plant with pipe trestle, pump houses, etc., for all acids pumped to the explosive plant. Fig. 11 is the denitrating end of the spent acid. The concentrating plant can just be seen in the distance to the right.

There were used in the construction of these plants roughly speaking 2,000,000 common brick, 110,000 stack brick, 2,000,000 fire brick, 1,500,000 acid brick and 6,000,000 ft. of lumber, 500,000 building tile, 38,000 yd. of concrete, 120 tons of reinforcing rods, 3000 tons of fabricated structural steel, 40,000 ft. of steel and wrought iron pipe, 6000 ft. of cast iron pipe, 8900 tons of special iron castings, 1750 tons of sheet lead, 1314 tons of steel tanks and 715 tons of acid-resisting iron castings.

There was also used 4760 hp. of motors, 158 pumps of cast iron, steel and special acid-resisting iron, 28 low pressure blowers of 2000-ft. capacity each, and considerable quantities of miscellaneous material, among which was 1000 tons of coke, 90 tons of mineral wool, 3700 tons of rock quartz, 128 sets of recording pyrometers, and many miscellaneous articles. There was an average of 20 cars per day to be unloaded and distributed, in addition to which large quantities of all kinds of material were delivered by truck.

The acid plants were built and organization furnished by the Leonard Engineering Co. of New York and Chicago, of which Mr. H. E. Hollister was consulting chemical engineer and technical superintendent. Mr. C. E. Hollister was superintendent in charge of transportation and materials. Mr. W. M. Kallasch was manager.

The Ordnance Department officers in charge of the operation deserve unlimited credit and thanks for their hearty co-operation and assistance. It was through their untiring efforts that many a delay was avoided.

FIG. 11. SPENT ACID PLANT. DENITRATING TOWERS IN THE FOREGROUND

Electrochemistry in Its Human Relations

Electrochemistry Can Contribute to Human Progress and Raise the Standard of Living by Providing Cheap Fertilizer for Increased Crop Yields—It Can Improve Sanitation and Produce New Materials of Construction

BY F. J. TONE*

DURING recent years it has been a custom which has now more or less become a dictum that the annual address of the president shall treat of some of the broader aspects of electrochemistry. We have in turn had discourses on the æsthetics of electrochemistry, its external activities, its economic forces, and its public relations. I need offer no apology, therefore, in starting out this morning to make some observations on electrochemistry in its human relations. We are human beings as well as electrochemists, and we may well study the relations of our science to the world problems of today and how we can give most immediate and most effective service for the betterment of human society.

For four years we have been in the thralldom of a great war. We have been passing through a period of violent evolution, the nature and extent of which we have hardly begun to measure or realize. Science and industry, and in fact every human activity, emerges from this world turmoil with new and rapidly shifting viewpoints and new responsibilities, and electrochemistry forms no exception. It is, therefore, profitable at this time to take some survey of our present situation and to forecast our future activities and responsibilities in the new alignment of human relationships. If a new era has begun, what is our part in it?

Big Results of the War

I shall not try to outline any "fourteen points" of future social progress or to say whether some of our values by which we measure such progress are true or false, but one or two things can be stated with a fair degree of assurance. As one of the big results of the war new and better conditions of living are demanded by the masses of the people in all countries. If a higher plane of living in the matter of food, clothing, housing, fuel and sanitation is to be established, and if shorter hours of labor and more opportunity for recreation and self-improvement are to be the order of the new day, this can only be bought about by vastly increasing the production of all the essentials which enter into the needs of modern society. Not forgetting such factors as co-operation, efficiency of organization and distribution and elimination of wastes, production can be increased principally in two ways, first, by using labor more efficiently, and, second, by further supplementing and supplanting labor by the chemical and mechanical instrumentalities of industry. Either we must get more out of labor or we must stimulate the discoveries that will make labor more productive than before. If the world is going to work less, science must work more. The work of the world cannot be done in a six-hour day and a thirty-two-hour week unless applied science gets in a lot of time-and-a-half on week days and double-time on Sundays.

Among the problems of first importance is that of the world's food supply. The crop yields of the world must be vastly increased, and this in the face of a decreasing labor supply. If cereals, cotton and animal fodder must be produced in greater quantity and more cheaply, the answer can only be found in improved transportation and traction for the farmer and in a vastly extended use of fertilizer, and here rests a big problem with the electrochemist.

Judged by European standards, the American farmer is inefficient. He produces fourteen bushels of wheat to the acre, while in Europe the same acre yields thirty. European yields all along the line average from 50 to 100 per cent greater than American yields, and while this increase is in part due to intensive farming, better selection of seed and crop rotation, the big difference is in the enormously greater use of fertilizer. It is of the highest economic importance that the American farmer shall use more fertilizer.

The Electrochemist's Part

The three main elements of plant food are nitrogen, potash and phosphoric acid, and each one of these carries a problem for the electrochemist. The fixation of nitrogen is one of the great triumphs of electrochemistry and the possible exhaustion of the natural nitrate fields is to us no longer a matter of any anxiety. So long as we have energy and air the land need never want for ammonia. Still, the efficiency of the arc process of fixing nitrogen is today less than 5 per cent, and between this figure and the best efficiency attainable, there is certainly breathing space for the most energetic of our research workers. The extension of the cyanamide process has been one of the remarkable chemical events of the war. Its opportunity for peacetime accomplishment is no less, but we still have some distance to go before artificial nitrates can be laid down to the farmer in such quantity and at such price as will mean the doubling of our crop yield.

The Potash Question

The potash problem during the war has been brought into the field of electrochemistry. The Cottrell system of electrostatic precipitation has been successfully applied to blast-furnaces and cement plants, and if all the waste gases from such plants were treated by the Cottrell process, the possible recovery of potash is equal to our pre-war consumption. We can hardly hope that this is commercially possible, but in many localities it will give a permanent source of potash which will maintain its existence under competitive conditions. What the electric furnace can do in phosphoric acid recovery

*Presidential address delivered at the 35th general meeting of the American Electrochemical Society in New York City, April 3, 1919.

is not so well proven. But passing over this, we see that the solution of our national food problem is one in which, despite our past accomplishments, we still have large responsibilities.

In the new order of things we are going to banish the slums and have more heathful living conditions, and the rôle of the electrochemist in sanitation is told in the story of chlorine. We learn that when the armistice was signed we were just ready to deliver each day to our fighting forces on the western front over 200 tons of poison gas. The basis of this great offensive weapon was chlorine, and it was denied its opportunity to demonstrate in a big way what it could do to win the war against the Huns, but I believe it has a far greater opportunity in the germ warfare of peace times.

Chlorine in Sanitation

In starting to investigate the work that chlorine is doing in sanitation, I knew in a general way that it was of growing importance in the purification of drinking water, but upon assembling all the data it was astounding to find that chlorine is today making safe the drinking water of more than 20,000,000 people of this country who dwell in cities. Chlorine is safeguarding one-fifth of our population from typhoid. We learn that a military force or an industrial expedition can go anywhere in the tropics and be at all times assured of potable water if it carries a few pounds of hypochlorite. In the Carrel-Dakin solution for the treatment of wounds, the use of chlorine is defined by a recent authority as the greatest discovery of surgery in the whole war. During the recent epidemic of influenza the number of cases in the cell rooms of two electrolytic chlorine plants located in different States was one-half of that in any other portion of the plants. Starting with a few such facts as these, what more is needed to build up a great structure of organized sanitation with chlorine as its basis? We are looking for an outlet today for a huge producing capacity brought about by the demands of the war. Do not these examples of what chlorine is doing in germ warfare clearly point the way?

Sterilization of Sewage

The sterilization of sewage is as logical a measure of sanitation as the sterilization of drinking water. To be sure, no city drinks its own sewage, but some other city generally does. Why permit Chicago and Milwaukee, Detroit and Cleveland to pollute the waters of Lake Erie, Lake Ontario and the St. Lawrence? Why should Pittsburgh pass its germ-laden water on to Cincinnati and Louisville when an adequate remedy is available at reasonable cost? One hundred and twenty pounds of hypochlorite will sterilize 1,000,000 gal. of screened sewage. A city of 1,000,000 inhabitants can sterilize its sewage at a cost for its chemicals of $360 per day. The cost for a single inhabitant for one year would be about twelve cents.

But the work of chlorine does not stop with water supply and sewage. It should be used to flush and sprinkle our streets, to clean our cars and public buildings and to sterilize our dairies. The organized use of chlorine in sanitary milk production will do more to give our children a pure milk supply than any possible system of inspection.

We are searching for an outlet for our excess chlorine in metallurgy and in organic chemicals. If our electrolytic chlorine friends would begin telling people how they can live in a prophylatic environment, how they can feed their babies pure milk and how they can avoid poisoning their neighbors who live lower down on the same watershed, conditions in the chlorine market would soon be such that they would no longer worry about what the Government is going to do with Edgewood.

Super-Steel

Again, in the metallurgy of steel, if electrochemistry has made great contributions to the art, its responsibilities are no less clearly defined. No one now doubts that we shall soon attain to the super-steel and it is no less clearly indicated that this will be accomplished by the electric steel furnace and electrically produced alloys.

The triplex process using the electric furnace as the third step for the refining operation produces a steel of crucible quality at a cost of a few dollars a ton more than open hearth steel. When it is understood that such steel produces rails which do not break and plates which do not fracture, it will require no advertising campaign in the popular weeklies to bring this product into universal use. Public opinion will demand it.

The alloy steels have made possible the modern automobile, the aëroplane engine and the farm tractor motor. Alloy steels have been a luxury. They have been used only in the vital parts of the mechanism where enormous strains must be met with a minimum weight of material, but their use must be extended. High quality is not incompatible with tonnage. It is the work of the electrochemist to make possible their use as common materials of engineering, thus contributing vastly to improvements in transportation and the mechanical arts. No one needs to have pointed out what this signifies as an economic gain in modern life.

But the field of alloy steels has by no means been fully exploited. The results which the steel maker has achieved with tungsten, molybdenum, chromium and vanadium, marvelous as they are, by no means mark the limit of the art. We now seem to be on the eve of still more important advances based on the use of new alloys including ferro-uranium and ferrozirconium. We hear whispers about a zirconium steel of 300,000 lb. tensile strength and 30 per cent elongation. Not being a steel maker and having no metallurgical reputation to lose, I may venture in my imagination to build an ocean liner or a freight train of this super-steel in which the dead weight is cut in half and the carrying capacity is increased 25 per cent; or, may I visualize the super-steel bridge and finally the super-steel Pullman car, but, in the latter case, we are not so anxious to reduce the weight of the car and save steel. Rather we will make the super-steel Pullman four times as strong with the same weight of steel, and then sleep soundly in the rear section of the rear car while the second section of the train follows one short block behind. Briefly stated, the job of the electrometallurgist is to put super-steel on a big tonnage basis.

Let us now consider energy resources. These are fuel and water power, and their proper utilization not only will reduce the sum total of human toil necessary to run our industrial machine, but is a measure of vital importance to coming generations. Our energy resources are necessary to the functioning of every other resource. They are at the very basis of industrialism, transportation and domestic well-being. Thus they con-

cern society broadly, but they peculiarly concern the electrochemist because cheap electric power is a basic element in electrochemical production. The electrochemist was responsible for the success of the world's first great hydro-electric development at Niagara and became the natural champion of the utilization of our water power resources. But why have we failed to sell this proposition to the man in the street and to those whom in his wisdom he has chosen to legislate for him? There may be many reasons for public indifference to coal economics and the waste of water power, but the fact remains that we have as yet failed to state the simple facts and principles of our energy economics in a way which carries conviction to the people with whom responsibility for action lies. Here are some of them:

1. Coal is our greatest energy resource. It is irreplaceable and notwithstanding an apparent popular belief to the contrary, it is not inexhaustible. The amount available for present and future generations is known to be very definitely limited. The curve of consumption is rising regularly and rapidly and we can compute with a fair degree of accuracy when our magnificent coal reserves will be exhausted.
2. Coal is wastefully mined, wastefully transported and wastefully utilized. If the bituminous coal used for domestic heating alone was first converted into artificial anthracite and the by-products recovered, it would represent a saving of more than twice our entire output of gold for 1917. If our railroads were electrified and fed from central stations recovering the by-products, this saving would be doubled.
3. Fuel and water power are practically interchangeable in industrial economics. The failure to use water power is just as truly a waste as would be the burning of our coal mines and oil wells. If Congress were to enact legislation to set the torch to one-third of all of our coal that was mined in the country last year, it would be no greater an act of folly or a crime than to obstruct water-power development. The utilization of water-power resources will save coal and oil for future generations and release for other useful work in the present generation hundreds of thousands of miners, vast transportation facilities and thousands of railway workers.

Legislation Suggested

Having convinced the people that water power must be developed, perhaps the most difficult part of the problem remains to be solved, which is to arrive at a form of legislation in which the people and the capitalist believe that their respective interests are protected. Passing over the question of Government ownership of water powers, I believe we must all now agree that no legislation for private development stands any chance of enactment which does not carry with it a very much larger measure of public control than would have been acceptable a few years or even a few months ago. Political ideas have changed, and one can plainly observe that public sentiment will not again consent to the development of its water powers as an unrestricted private monopoly. It would not so consent even when awakened to the great economic crime of letting them run to waste. After all, what we want is the power and I believe this Society can not do less than endorse legislation in which public interests are fully protected by control of rates and proper limitation of charter rights. Following this we want Government surveys covering our complete energy resources and their utilization.

My conclusion shall be brief. It is plain that our science faces some of the big human problems of the day. Our opportunity for service was never greater, and I believe it will not be passed by.

Salvaging Industrial Casualties

By Douglas C. McMurtrie

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IN THE PAST, our method of dealing with men permanently disabled in the course of employment has been to pay the worker a pension in the form of compensation, and forget him and his injury. But the cost of disability in the metal trade has not been alone in the premiums paid for casualty insurance. There has been the cost involved in the training, experience and adaptation of a skilled worker who does not return to his job, and the fitting of a newcomer to take his place.

There are three means of reducing and approaching the complete elimination of the cost of disability: first, accident prevention; second, thorough medical attention to minimize the disability resulting from the injury, and third, salvage of the remaining abilities of the worker through rehabilitation for self-support. The first of these has already received wide attention from employers and has wisely been encouraged in a financial way by casualty insurance companies and State funds. The values of the two latter have, however, not as yet been appreciated. Their energetic application would effect a tremendous saving to industry.

Insufficient Medical Treatment

Many injuries from which men would completely recover in a short time under adequate and high-grade medical attention are treated for an insufficient time, or by incompetent physicians, and, instead of a prompt return to work, the case at best drags along over an extended period and at worst becomes chronic or develops into permanent disability. Some States require the insurance carrier to provide but two weeks of compulsory free medical attention to the injured man. For the insurance company to take advantage of this limitation is the most short-sighted policy possible, because for every dollar saved in physicians' or hospital fees, the insurance carrier pays out later ten dollars in compensation. And what the insurance company pays is actually paid by the insuring employers in their regular premiums.

Unlimited medical attention of the highest grade should be an axiom of casualty practice. It should be insisted upon by employer and workman alike. The best outcome of any injury is to have the employee return to his job a well man in the shortest possible time. It is well to develop a science of dealing with cripples, but the ideal is to have fewer and fewer cripples with which to deal.

Rehabilitation for Self-Support

The third method of attack on the cost of disability is rehabilitation for self-support—the re-education of an injured man for an occupation which he can follow, or a process which he can perform, in spite of his handicap. The science of rehabilitation is new, and the experience in it has practically all been gained in the effort to make sound and just provision for the disabled soldier or sailor. Every country among the recent belligerents is to-day operating a comprehensive system of re-education for disabled soldiers, and is placing upon that system more dependence than upon the pension system.

Paying a man a small monthly or weekly stipend on which he is expected to live in idleness is not a very constructive method. With the breakdown of confidence

in the pension system, it was realized that the only real compensation for disablement was restoration of capacity for self-support. It was further realized that very few jobs require all the physical faculties and that in the present-day variety of industrial processes it is possible to find a job in which a man with a given type of disability can function 100 per cent efficient. Some jobs are standing, some seated, others require walking about; some jobs at a bench working on small articles require but little strength, others involve great physical exertion. Still others do not require the sense of hearing; in others the sense of sight is not essential. Finding the future work of the disabled man, therefore, requires expert and painstaking choice, but a successful selection is possible even for the seriously handicapped. The first aim is to place the man back in a different job in his own trade or in a trade closely related. In such a job his past experience will stand him in good stead. Failing this, he can be re-trained for a different line.

Schools for Crippled Men

The process of re-training the disabled is known as re-education, and can best be provided in a special school for crippled men. The first school of this kind in the United States is the Red Cross Institute for Crippled and Disabled Men, established in New York City through the generosity of Jeremiah Milbank. At this school, open to disabled civilians and soldiers alike, six trades are already being taught: artificial limb making, motion picture operating, oxy-acetylene welding, printing, jewelry work, and mechanical drafting. More will be added as the demand develops. Graduates are already giving satisfaction in the jobs to which they have been graduated, so the enterprise has passed the experimental stage. And in the results attained with disabled soldiers abroad there is overwhelming evidence of the logic and practicality of rehabilitation.

The cost of soldier rehabilitation is being met by the United States Government and by the Governments of some of our allies. It will be admitted without argument as desirable that the advantages of re-education be made available to disabled civilians as well, but will not the cost be prohibitive? The fact is that rehabilitation effects a reduction rather than an increase in the cost of disability to industry or to the community as a whole.

A Typical Case

A typical case will illustrate how the saving is effected. A worker in Massachusetts was injured by a fall while working inside a submarine and his hand became permanently crippled. In due course his compensation rate was determined and he was referred to the insurance carrier to be paid $10 a week for a long period, with a maximum total payment of $4000. Since the disability was manifestly permanent, the insurance company wrote the case off its books as a $4000 loss and transferred that amount to reserve to cover the weekly payments. After the compensation had been paid for nearly a year, a new official of the insurance company began looking over the list of men to whom the company was paying compensation. His attention was directed to the man in question and the latter was requested to call at the office of the company. The case was, like many thousands of others, susceptible of rehabilitation for self-support, so the insurance company official put a proposition to the man in very frank terms. "I believe that you can be trained to earn a good living. I want you to understand very clearly, however, that this proposal is to the financial advantage of the company, but I also believe it is to your advantage as well. A total income of $10 a week is not very attractive to you and you would probably rather return to work at a good wage than remain idle. If you will consent, the company will send you to a school of re-education and see if we cannot get you back on your feet in good shape."

The injured man consented to the proposal and the company sent him to the Red Cross Institute in New York. They began to pay him not $10 a week, as required by law, but $40 a week, $20 to him in New York and $20 to his wife at home. The company also paid his traveling expenses in both directions. In eight weeks he was re-educated in oxy-acetylene cutting and welding and returned home. He is now making not only a satisfactory wage but twice as much as he had ever earned before the accident took place.

Every Party in Interest Benefited

In the whole transaction every party in interest was benefited. The man was advantaged in that his general living standard was distinctly raised, and the necessity of working for his living could not be considered as a hardship. The company paid less than $500 for his rehabilitation, and this expense, in conjunction with the $500 already paid in weekly compensation during the first year of idleness, made a total for the case of $1000. It was thus enabled to credit $3000 profit to the account of profit and loss. The community was infinitely the gainer in that the man, formerly an unproductive consumer, became a useful producer instead. The community further gained in the elimination of the disabled man from the category of a prospective dependent, because while compensation might have taken care of him in a very insufficient way during the period of idleness, there would have come a time when compensation ceased and then he would have been in a desperate economic status indeed—confirmed in habits of idleness, untrained for skilled work, and without any source of support.

Revision of Compensation Laws Needed

A more intelligent handling of disability by insurance carriers will, therefore, reduce their expense, and will thus cut the cost of casualty protection to the employer. There is needed also, however, some revision of compensation laws so that there may be definite encouragement to insurance carriers to offer opportunity of rehabilitation and definite encouragement to the disabled men to take advantage of it. Practically every compensation case that has ever come to the Red Cross Institute has come on the day his compensation expired. For one year, for two years, or for four years the man has existed in idleness, drawing compensation, and cultivating habits of indolence. When his support was cut off, he then became interested in re-habilitation. Present compensation legislation tends to encourage the man to remain idle because his payments are reduced by any improvement in earning capacity. A revision of this practice will make for more constructive provision.

In short, the first effort should be to prevent injury, the second to minimize its permanent effects, the third—when disability has ensued—to offset its economic consequences. The execution of this complete program is not only sound humanitarian practice—it is good business as well.

Effect of Certain Accelerators Upon the Properties of Vulcanized Rubber

Experimental Data on the Activity of Certain Organic and Inorganic Accelerators—Magnesia in Small Amount Is Less Active Than Certain Organic Accelerators, and Does Not Impart to the Mixtures the Physical Improvement Characteristic of the Latter

By G. D. KRATZ and A. H. FLOWER*

THE relative accelerating effect of inorganic and organic accelerators has been subject to a diversity of opinion ever since the latter have been employed in technical practice. Likewise, the effect of each upon the quality and physical properties of the vulcanized rubber has been a matter of discussion.

The results recorded in the experimental part of this paper were obtained in the course of several investigations carried on for the joint purpose of determining the relative activity of certain inorganic and organic accelerators, and the permissibility in the use of the sulphur coefficient in evaluating samples of vulcanized rubber known to contain accelerators. As recorded here, this has consisted primarily in (*a*) a comparison of the relative effects of heavy calcined magnesia and an (unidentified) organic accelerator in a mixture containing only rubber and sulphur, and (*b*) a comparison of the effect of larger amounts of heavy calcined magnesia, light magnesia and lime in a mixture which contained an excess of zinc oxide.

Irrespective of the effect of accelerators upon the physical properties of the vulcanized mixture, possibly the advantage most often claimed for the organic variety in preference to inorganic substances is that, in accelerating vulcanization, the former are much more active than the latter and can be used in small amount to replace much larger quantities of litharge, magnesia or lime. Incidentally, the use of heavily pigmented mixtures is avoided by this substitution. Van Heurn[1] and many others[2] have given figures subject to this interpretation. In a recent communication, however, H. P. Stevens[3] has taken exception to this view, and, further, has obtained results which show that magnesia is more powerful than the inorganic accelerator litharge, or even the organic accelerator isonitroso-dimethyl-aniline. While Van Heurn has also given figures for vulcanization coefficients which show that magnesia is more powerful than litharge, unlike Stevens, he found one-fourth of 1 per cent of p-nitroso-dimethyl-aniline to be more active than even 1 per cent of magnesia.

General Part

Although our investigations have not included a comparison of the relative effects of magnesia and p-nitroso-dimethyl-aniline, the organic accelerator which we employed in place of the latter substance was found to be far more active, when used in small amounts, than were similar quantities of magnesia. Likewise, the physical properties of the mixtures which contained the organic accelerator were shown to be superior to those obtained with similar amounts of magnesia. This, however, did not at first appear to be the case owing to discrepancies found to exist when the load required to effect a given extension is taken as a measure of the physical properties[4]. In this instance then, the sulphur coefficient may be said to afford a fair index of the state of cure, as measured by the physical properties, of mixtures known to contain small amounts of either inorganic or organic accelerators.

This statement, however, was not found to be of general application, and certainly is not true for mixtures which contain larger amounts of inorganic accelerators in the presence of an excess of zinc oxide. We have never regarded zinc oxide itself in the same manner as Van Heurn[5], who found it to act as a retardent of the vulcanization reaction. Nor have we, with King[6], classed it, strictly speaking, as an accelerator. Our experience has been more similar to that of Ditmar and Theiben[7], who found that large amounts of zinc oxide effected a slight, and limited, increase in the rate of vulcanization (sulphur coefficient).

On the other hand, contrary to what might be expected, we have found that mixtures which contained fairly large quantities of both magnesia and zinc oxide, when vulcanized to maximum physical properties, had lower sulphur coefficients than a control mixture which was vulcanized to the same degree without the assistance of an accelerator. The substitution of lime for magnesia in such a mixture, however, was found to produce quite a different effect. With lime, after an initial decrease in the sulphur coefficient, the latter value was found to respond to a further increase in the amount of accelerator. This difference in the action of the two substances would indicate that their function in the mixture is not identical.

Our results with heavy mineralized mixtures have shown that such mixtures are not only subject to misinterpretation, but also that (as has already been stated by Eaton and Grantham[8]) the constituents of the mixtures tend to obscure or mask the individual properties of the rubber used. With this the case any formula, such as proposed by Dannerth and Gage[9], is untenable for the valuation of raw rubbers.

Fundamentally, the purpose of any ordinary vulcanization is to obtain the maximum physical properties which the mixture will retain unimpaired over the longest period of time under the conditions to which it will be subjected. Our experience in the past has been that this physical condition may be largely independent of the sulphur coefficient, particularly if the mixture has been vulcanized with the assistance of an accelerator. Generally speaking, we have not found that the sulphur coefficient affords a reliable indication of the physical properties of a vulcanized rubber mix-

*Read before the New Jersey Chemical Society, Jan. 13, 1919.

ture or that it can be taken as a measure of the state of cure except possibly in the case of mixtures which consist of rubber and sulphur only. We agree with Stevens[9], however, that for *hevea* rubber practically all mixtures with a sulphur coefficient in excess of 3.2 will be subject to rapid deterioration.

In a former paper[11] we have given the limits for the vulcanization coefficient of *hevea* rubber at 1.7 to 2.8. Under standardized conditions, the higher figure has been found to be consistently approximated by mixtures vulcanized without the aid of an added accelerator, or with the assistance of one which is only mildly active. The lower figure has been found to apply for mixtures vulcanized with the assistance of even small amounts of powerful organic accelerators or larger amounts of magnesia. The anomaly found to exist between the action of magnesia and lime, however, indicates that a certain amount of reservation should be made in interpreting the coefficients of mixtures which contain either of these substances.

In view of our results as a whole, while we agree with Stevens[9] that the sulphur coefficient is most important as an indication of the ultimate stability of the product, in general practice it should be considered as an indication only. Even in the case of mixtures composed solely of rubber and sulphur we have found it dangerous to evaluate between them on the strength of their sulphur coefficients alone, unless the past histories of the samples in question are definitely known. As Stevens[9] has stated in a subsequent communication, the true value of a product, as expressed by its state of cure, is obtained from physical and chemical tests only when they have been made after a definite period of aging conducted under carefully standardized conditions. Our results along these lines will be reported upon in the near future.

Experimental Part

As a considerable portion of the work described in this part was carried on prior to our repetition of Stevens' experiments, the same sample of rubber could not be used throughout. However, the same sample of rubber was employed for all of the mixtures in each of our experiments.

The rubber used was good quality, thin pale first latex (*hevea*) crêpe. In each instance the sample was subjected to the minimum amount of milling necessary to work in all of the ingredients. Where small quantities of accelerators were used the total time of each mixture on the mill was 18 to 20 minutes[9]; with the mixtures which contained larger amounts of accelerators and zinc oxide this time was increased to 22 to 25 minutes. All mineral substances were previously sieved through a 100-mesh screen.

The heavy calcined magnesia was previously ignited and found to contain 92.73 per cent MgO. Specific gravity 3.24.

The extra light magnesia gave a loss of 4.0 per cent on ignition, after which it was found to contain 94.0 per cent MgO. Specific gravity 2.82.

The lime was air slaked, gave a loss on ignition of 13.46 per cent and contained 55.12 per cent $Ca(OH)_2$. Specific gravity 2.19.

The zinc oxide was lead free. Specific gravity 5.64.

Accelerator "A" was prepared by the condensation of an amine with formaldehyde. It was of C. P. quality.

In all instances, after mixing, a rest period of 24 hours was allowed before vulcanization. A recovery period of 7 days was then permitted before physical tests or sulphur estimations were made. The combined sulphur was estimated by the method of Rosenstein-Davies[10]: the samples, having first been subjected to 24 hours continuous extraction with acetone in a Soxhlet apparatus, were dried in air and then in vacuo at 100 deg. C. to constant weight. The sulphur coefficients given represent the combined sulphur of vulcanization expressed as a percentage of the rubber in the mixture.

$$\text{Sulphur coefficient} = \frac{\text{per cent combined sulphur in the mixture}}{\text{per cent rubber in the mixture}}$$

The physical properties of the mixtures which contained small amounts (0.10 to 1.25 per cent) of accelerators were measured by the method employed by Stevens, *i.e.*, measurement of the load required to effect an extension of one to nine, and also at break for tensile strength and percentage elongation. In making this comparison, figures for both methods were obtained on the same sample or test piece by recording the load required to effect the given extension and then increasing the load and continuing the extension to breaking point. Each figure given in the following tables is the average of at least three test pieces.

Irrespective of the adaptability of the two methods as a means of testing samples of different mixtures, both of them are subject to criticism. The measurement of the load required to effect an extension of one to nine was unsatisfactory in that even small amounts of magnesia decreased the percentage elongation to such an extent that this extension was made just short of the point of rupture, or break. The danger of misinterpreting the results obtained by this method, due to this feature, is commented upon elsewhere in this article. This method would be more generally applicable if the load required to effect a lesser extension was recorded. On the other hand, when tested at break, the samples which contained but small amounts of accelerators had a tendency to be cut by the clamp holding the test piece, before the point of rupture was reached.

Note: The mixtures which contained zinc oxide were tested at break only. All results were obtained on a Scott testing machine of the vertical type.

Experiment 1

In this experiment we first followed the plan outlined by Stevens and have compared the accelerating effect of magnesia against an organic accelerator which we have called Accelerator "A." The effect of these accelerators was tested in the same mixture as previously employed by Stevens, namely, 90 parts of rubber and 10 parts of sulphur[9], with added amounts of the accelerators varying from 0.10 to 1.25 per cent on the rubber content. Vulcanization was carried on in a platen press for 60 minutes at 35 lb. steam pressure (281 deg. F.), after which sulphur estimations and measurements of the physical properties were made on the vulcanized products in the manner previously described.

We found the vulcanization coefficients of the series actuated by our "Organic Accelerator A" to be uniformly higher than those obtained with similar amounts of magnesia. (Col. 3, Tab. I, and Fig. 1). This difference between the results obtained by Stevens and us is readily accounted for in the selection of the organic accelerators employed. His accelerator, as well as our own, is unidentified. When the physical properties of

our two series of mixtures were expressed in the manner adopted by Stevens, that is, by the measurement of the load required to effect an extension of 1 to 9, Accelerator "A" was found to have a slight advantage up to about 0.5 per cent, at which point magnesia produced superior results. (Col. 4, Tab. I, and Fig. 1A.) Thus, the physical properties of the series which contained Accelerator "A" are seen to be at variance with what would be expected from their respective sulphur coefficients, provided that the latter figures can be taken as an indication of the state of cure, as measured by the physical properties.

As the series which contained Accelerator "A" appeared to be much superior to the corresponding mixtures containing magnesia, when judged by the "thumb and tooth," it was felt that the physical properties of the two series were not fully expressed by the above method. They were then expressed in terms of the tensile strength and percentage elongation at break.

When interpreted in light of these results (Cols. 5 and 6, Table I, and Fig. 1A), an entirely different relation was seen to exist. Even in this instance, however, it cannot be said that a direct relationship exists between the sulphur coefficients and physical properties of the various mixtures. In the cases of the mixtures vulcanized with the assistance of Accelerator "A," it is evident from the figures obtained for the percentage elongation at break that this property increased coincidentally with an increase in the tensile strength[17]; with magnesia, on the contrary, the tensile strength was increased at the expense of the elongation.

This difference in the effect produced in the percentage elongation by small amounts of accelerators prohibits the use of the load required to effect a given extension as a measure of the physical properties of the two series of mixtures. As the percentage elongation of a mixture is increased, by the action of an organic accelerator or otherwise, unless this is accompanied by a corresponding and uniform increase in the tensile strength, a given extension will be effected by a lesser load than would normally be required. This was roughly found to be true with Accelerator "A." On the other hand, when the tensile strength is increased at the expense of the elongation, as was found to be the case with magnesia, it will require an excessive load to effect the same extension. This decrease in the percentage elongation of mixtures which contained small amounts of magnesia was so marked that, with 1 per cent of this substance, an extension of one to nine was produced only by a load just short of that required to produce rupture, or break.

TABLE I.

Accelerator Used	Per Cent Accelerator	Sulphur Coefficient	Load in G. per Sq.Mm. Extended 1 to 9	Tensile Strength in G. per Sq.Mm. (at Break)	Per Cent Elongation at Break
Heavy Calcined Magnesia	0.00	0.684	163	181	962
	0.10	1.012	...	564	937
	0.25	1.287	501	774	950
	0.50	1.500	633	766	912
	0.75	1.873	832	914	900
	1.00	1.724	886	914	912
	1.25	1.821	883	1002	918
Accelerator "A"	0.00	0.684	163	181	962
	0.10	1.202	402	621	925
	0.25	1.609	630	871*	900*
	0.50	2.079	678	1153*	975*
	0.75	2.347	664	1170*	1025*
	1.00	2.518	636	1250*	1037*
	1.25	3.004	642	1223	1087

* These samples were pinched through by the clamps of the testing machine before the point of rupture, or break, was reached. Consequently, the results for tensile strength and elongation at break are low.

TABLE II.

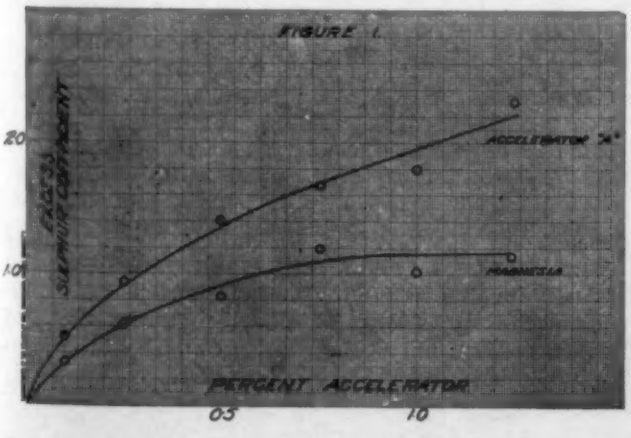
Accelerator Used	Mixture	Per Cent Accelerator on Rubber — 0 Per Cent	5 Per Cent	10 Per Cent	15 Per Cent
Heavy Calcined Magnesia	First Latex	100	100	100	100
	Zinc Oxide	100	92	83	74
	H. C. Magnesia	...	5	10	15
	Sulphur	5	5	5	5
Light Magnesia	First Latex	...	100	100	100
	Zinc Oxide	...	90	80	70
	Light Magnesia	...	5	10	15
	Sulphur	...	5	5	5
Lime	First Latex	...	100	100	100
	Zinc Oxide	...	87	75	62
	Lime	...	5	10	15
	Sulphur	...	5	5	5

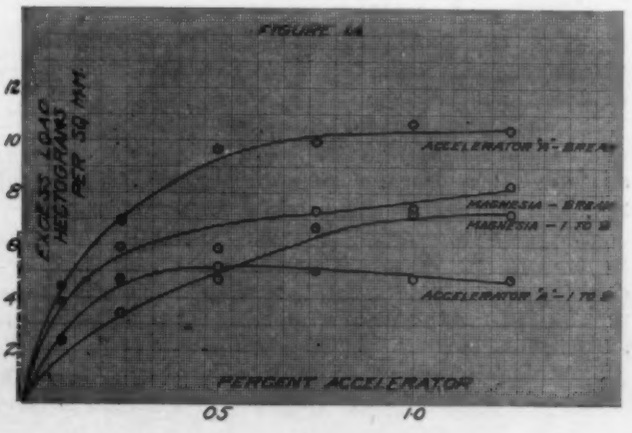
TABLE III.

Accelerator Used	Per Cent Accelerator	Time in Minutes for Technical Cure at 298° F.	Tensile Strength at Break, G. per Sq. Mm.	Elongation at Break, Per Cent	Sulphur Coefficient
Control	0	120	1,331	725	3.075
Heavy Calcined Magnesia	5	90	1,553	700	2.586
	10	75	1,627	725	1.723
	15	45	1,402	675	.....
Light Magnesia	5	90	1,322	700	2.780
	10	45	1,875	750	2.184
	15	40	1,350	775	.....
Lime	5	90	1,294	800	1.990
	10	45	1,565	750	2.926
	15	40	1,512	750	.....

Experiment 2

In the following work, where much larger amounts of inorganic accelerators were employed, it was desired that the effect of the accelerator as a filler should be minimized to the greatest possible extent. This was accomplished by employing mixtures which contained zinc oxide in such an excess that from 5 to 15 per cent of an inorganic accelerator could be included in the mixture, by replacement of a similar volume of zinc oxide, without decreasing the effect, or function, of the latter





substance (Tab. II). The sulphur content of the various mixtures was also cut down from 11 to 5 per cent, calculated upon the rubber. In this instance, and unlike the preceding experiments, the mixtures were vulcanized to maximum physical properties and their respective sulphur coefficients determined at this point. Portions of each of the mixtures were vulcanized in a platen press at 50 lb. steam pressure (298 deg. F.) over a wide range of times and the correct cure determined as the point of coincident, maximum tensile strength and percentage elongation (technical cure[16]). The sulphur coefficient of each mixture when vulcanized to this degree was then determined (Col. 6, Tab. III).

The results obtained show that, for all three of the accelerators used, the best physical properties were obtained with about 10 per cent of each in the mixture. The effects produced by light magnesia, heavy calcined magnesia and lime ranked in the order named. These differences, however, were small enough to be accounted for in the value of each of these substances as a filling material. However, it is evident that the value of these accelerators as filling materials is of limited extent, because, when present in larger amount (15 per cent), in each case the vulcanized mixtures showed inferior physical properties (Cols. 4 and 5, Tab. III). Moreover, the sulphur coefficients of the various mixtures were not found to reflect, or be a measure of, their physical properties. With both varieties of magnesia, the mixtures which contained 10 per cent of these substances were found to have lower sulphur coefficients than the mixtures which contained but 5 per cent, and the latter had lower coefficients than the control which was vulcanized without the assistance of an accelerator. On the other hand, the results obtained with lime were remarkable in that with 5 per cent of this substance, a much lower sulphur coefficient was obtained than in the case of the control, while with 10 per cent, contrary to the results obtained with magnesia, the sulphur coefficient was increased almost to that of the control.

In explanation of the results obtained with magnesia, we have consistently found that mixtures vulcanized quickly to maximum physical properties with the assistance of accelerators invariably show lower sulphur coefficients than similar mixtures also vulcanized to maximum physical properties but without the assistance of an accelerator. Frequently, much higher physical values are developed by those mixtures which contain accelerators. The same is true in lesser extent when a short period of vulcanization is effected by the use of higher temperatures. It is at least indicated that the time required to effect the cure of a given mixture is reflected both in its sulphur coefficient and physical properties.

CONCLUSIONS

In view of the foregoing results we have been led to the following:

1. That the physical properties of vulcanized rubber mixtures are more fully expressed in terms of the tensile strength and elongation at break than by the load required to effect an extension of one to nine.

2. When used in small amount magnesia is less active in accelerating vulcanization than certain organic accelerators, and it does not impart to the mixtures the physical improvement characteristic of the latter substances.

3. With mixtures which contain even small amounts of either inorganic or organic accelerators, no direct relationship exists between the sulphur coefficient and the state of cure as measured by the physical properties of the mixture.

4. When mixtures are vulcanized quickly with the assistance of inorganic accelerators, the correct state of cure, as reflected by their physical properties, is obtained at abnormally low sulphur coefficients.

Chemical Laboratories,
The Falls Rubber Company,
Cuyahoga Falls, Ohio.

REFERENCES

[1]Intern. Assoc. Rubber Cult. in Netherland Indies. Comm. of Netherland Govt. Inst. for Advising Rubber Ind., Part VI, p. 202.

[2]D. R. P. No. 265,221 (1912). D. R. P. No. 269,512 (1913). Brit. Pat. No. 4263 (1914). *Gummi. Ztg.*, 30, (1916), 303, 326.

[3]*India Rubber J.*, 55, (1918), 25, 5.

[4]This method as employed by H. P. Stevens [*India Rubber J.*, 55, (1918), 25, 5] and others, was found to be subject to correction, as it assumes that, in making comparisons between several samples, similar extensions will be effected by similar loads. Beadle and Stevens [*J. Soc. Chem. Ind.*, 30, (1911), 1421] have previously shown that the addition of as little as one-half of 1 per cent of zinc oxide or talc will produce a marked decrease in the extension of the vulcanized mixture. We have found the same to be true for small amounts of magnesia; certain organic accelerators, however, were found to increase the extension. With such the case, entirely erroneous results were obtained when two series of mixtures, one of which contained small amounts of magnesia and the other similar amounts of a strong organic accelerator, were tested by this method. We have found that comparisons made on the basis of the loads required to effect a given extension are less reliable than those obtained by comparing the tensile strength and percentage elongation at break.

[5]Intern. Assoc. Rubber Cult. in Netherland Indies. Comm. of Netherland Govt. Inst. for Advising Rubber Ind., Part VI., p. 202.

[6]MET. & CHEM. ENG., 15, (1916), pp. 231-4.

[7]*Kolloid Z.*, 11, (1912), pp. 77-80. In the course of this work, Ditmar and Theiben also found that lime under vulcanizing conditions showed a greater tendency to form thio-compounds than other substances such as MgO, ZnO, etc. In view of this, and the results obtained in experiment 2, we are led to class the action of lime in accelerating vulcanization as more similar to that of litharge than to that of magnesia.

[8]*J. Soc. Chem. Ind.*, 35, (1916), pp. 1046-50.

[9]*India Rubber World*, 56, (1917), pp. 583.

[10]*India Rubber J.*, 56, (1918), p. 2.

[11]*J. Ind. Eng. Chem.*, 11, (1919) p. 30.

[12]*India Rubber J.*, 53, (1917), p. 220.

[13]*J. Soc. Chem. Ind.*, 37, (1918), p. 280.

[14]Where less than 1 per cent of a mineral accelerator is worked into a rubber, it is extremely doubtful that it becomes uniformly distributed throughout the mass. When used in small amount (up to 3 per cent), and compared on the basis of their respective lead contents, we have found lead oleate to be more active in accelerating vulcanization than litharge. We attribute this largely to the unctuous nature of the lead oleate, which lends itself to a better incorporation with the rubber than litharge.

[15]*Chemist Analyst*, 15, (1916).

[16]The use of such a large quantity of sulphur is deprecated on the ground that it is in excess of the amount required to give a good vulcanization, particularly when employed in a mixture which also contains an accelerator. The excess of sulphur undoubtedly acts as a "filler," the effect of which is commented upon later in this experiment.

[17]Van Rossem (Reference No. 1, p. 214) has already noted that rubbers vulcanized with the assistance of certain organic accelerators show an increase in their percentage elongation at break. In this connection he has also found that, with similar amounts of an accelerator, the vulcanization of a rubber with a low viscosity value will be accelerated more than a rubber with a high viscosity value. This is explainable in light of the results of Spence and Kratz [*Kolloid Z.*, 14, (1914), p. 265], who found that small traces of acid decreased the viscosity of a rubber solution. As Van Heurn (*loc. cit.*) and others have found practically all accelerators of vulcanization to be basic, and retardents to be acidic, the accelerator is doubly effective in the case of rubbers of low viscosity in that it first counteracts the effect of the retarding agent and then accelerates the vulcanization. This will also account for the greater uniformity which is obtained in the rate of vulcanization of rubbers of widely different viscosity values when vulcanized with the assistance of an accelerator.

[18]*J. Ind. Chem. Eng.*, 11, (1919), p. 30.

Australia Prohibits Dye Importations

Australia has, by Government proclamation, prohibited the importation of all dyes (except those of British origin), unless the written consent of the Minister of Commerce and Trade is secured.

Decomposition of Metals—II*

An Application of Theory to the Commercial Problem of Manufacturing Durable Alloys Containing Tin and Aluminium, With an Outline of Recommended Melting, Drawing and Annealing Practice for Certain Munitions

By COL. A. I. KRYNITZKY

THE WRITER studied the question of disease of metals especially in view of its importance in the manufacturing of ammunition. Rifle and gun cartridge cases, bodies, and the time rings of aluminium fuses, tin preserving jackets and tin tubes for some of the types of fuses—all these highly important parts are liable to decomposition under certain conditions of manufacturing and storage.

A noticeable decomposition was observed on the walls of the fuse tin tubes, which were covered with cracks, specks, projections and rough spots. In some cases such decomposition was followed by the partial destruction of metal. As these tubes were drawn cold, the decomposition may be due to the "disease of cold forging." Similar decomposition would be expected from the stamped tin preserving jackets which are used to seal the fuses.

Fig. 12 shows a preserving tin jacket for the 22-second Russian time fuse. This jacket is in the first stage of decomposition. Part of it, as may be seen from the illustration, is already destroyed and the rest is covered with rough spots and projecting grain formations, all of which indicate an imminent decay.

Fig. 13 shows an aluminium body of a Russian 22-second fuse, made in 1904-05 in Keller's factory (Austria), which has decomposed in a typical manner. Here the decomposition affected the body of the piece and was photographed in Fig. 14 at four magnifications without any preliminary preparation. Chemical analysis of this metal showed the following composition: Al, 94.1 per cent; Sn, 3.3 per cent; Cu, 1.8 per cent. Unfortunately the writer was unable to ascertain whether these parts were subjected to cold forging or pressing or to some other process. Fig. 15 shows the same decomposed spot under 80 diameters. It was impossible to polish these places, as the metal was too brittle, and the writer did not wish to impregnate the mass with rosin or similar cement, in order to avoid raising any question as to the meaning of the photographs. It was accordingly very difficult to focus properly the destroyed portion on account of its roughness. The writer succeeded in getting in the picture most of the scattered bright pins and rods among the gray mass.

It is understood that in all cases the diseases and decompositions were observed in very uniform and good castings. No doubt defects in uniformity of the alloys are detrimental to the service rendered by articles, but such defects have nothing to do with the decomposition of the metal as described heretofore.

In discussing the reasons for the "strange and unexplainable" appearance of cracks and other signs of decomposition in cartridge cases, General Matunin (about 1908) advanced the explanation that the cracks are due to the changes in physical condition (temperatures, etc.), chemical factors (moisture and sulphurous gases), but mainly to the inner stresses set up by the cold forging or drawing. This comes very close to Heyn's theory.

Therefore the following factors should be considered as the reasons why decomposition starts and which may take place at any time within the course of years a piece may be in storage:

1. Additional external forces.
2. Stresses, due to the uneven heating and cooling.
3. Surface injuries caused by mechanical action or due to cleaning and washing.

These have already been adequately discussed in the former article, except perhaps the last. Brass pieces under heavy stresses due to cold forging often decompose and are ruined merely by immersing them in mercury or solutions of mercury compounds, or when subjected to the action of ammonia vapors. Sometimes this action is started by merely covering brass with red mercury paint and exposing the piece for a while to the action of moisture, causing HgS to react with the copper in the alloy, decomposing into mercury metal and forming copper sulphide.

According to researches of Henry S. Rawdon[28] on the deterioration of Muntz metal by selective corrosion (dezincification) the results were "strongly suggestive that brass of the α-β type highly stressed is more prone to selective corrosion than when not so, particularly when the stress is highly localized; for example, at the base of a fine haircrack or a narrow groove." Specimens here were immersed for varying periods in 5 per cent sodium chloride solution.

Heyn and Bauer found in their extensive study of the local decomposition of aluminium ware that the metal is affected differently by water and salt solutions, depending upon the condition of the metal and the kind of solution. The decomposition may spread evenly over the whole surface, affecting the underlying metal but little, or it affects the aluminium in spots only, where it becomes covered with white specks, similar to mold. The metal in such spots becomes spongy, peels off and finally is destroyed. The latter effect was observed in heavily forged or drawn samples (for instance in cold drawn sheets). On annealed sheets the water practically had no effect.

Here, of course, the main cause of the disease was cold drawing, and the internal stresses so set up may be

*The first installment of this article was published in CHEMICAL & METALLURGICAL ENGINEERING, Vol. 20, No. 6, March 15, 1919, p. 277.

[28] "Typical Cases of the Deterioration of Munts Metal (60:40 Brass) by Selective Corrosion," by Henry S. Rawdon. Technologic paper of the Bureau of Standards, No. 103, December 19, 1917.

removed by a proper anneal. Heyn and Bauer mention 500 deg. C. as a proper annealing temperature. The writer also has frequently observed the slight spotty decomposition of aluminium.

It was stated in the *Russian Artillery Journal* in 1912 that in many cases aluminium cables used for telephone, telegraph and trolley wires failed during and after sleet storms without any apparent cause. In such cases the aluminium has shown plainly a crystalline fracture. Aluminium wires suffer particularly near the seashore and in the vicinity of factories emitting vapor and fume of muriatic acid and alkalies. The writer thinks that such cases are evidence of disease in cold-drawn wires, which possibly could have been prevented by previous annealing.

Captain Crard of the French army in his article "Cartridge and Bullet Brass and Electrolytic Copper" (*Rev. de Met.*, 1909) brought forth numerical values for the safe compression of brass without intermediate

FIG. 12. DECOMPOSED TIN JACKET FROM 22-SEC. TIME FUSE

annealing. He found that the maximum possible deformation for brass should not exceed 200 per cent of the final cross-section, which corresponds to 33 per cent of the original thickness. He stated further that a stable condition follows tempering at from 350 to 450 deg. C. and complete annealing at from 750 to 830 deg. C. After an annealing at temperatures below 350 deg., brass does not remain stable for any length of time, but will develop cracks in the thinner parts. Temperatures above 830 deg. ruin the brass, causing it to lose its strength and durability and to become brittle.

In his treatise[11] Colonel Gronoff discusses the methods for preventing cracks in cartridge cases when stored for a length of time, and states that the cases should be made of metal with a uniform crystalline structure, avoiding excessive deformations in their manufacture, and between passes should be annealed at temperature near 750 deg. C. The mouths of the cases must be submitted besides to a special annealing. As may be concluded from the very extensive researches of Colonel Kourdumoff in Mickall Artillery Academy, Petrograd, Russia (his "Monograph of Copper-Zinc Alloys"), the tempering temperatures for commercial brasses range from about 200 to 400 deg. C.

[11]"Influence of the Methods of Manufacturing on the Mechanical Properties and Crystalline Structure of Worked Brass and Cupronickel and Tendency of These Alloys to Make Cartridge Cases With Ragged Edges," by Gronoff, *Bulletin*, Russian Technical Society, 1911, p. 401.

According to W. B. Price[12], the temperature at which internal strains of brass for cartridge cases are positively reduced if not entirely eliminated is about 500 deg F. (260 deg. C.). The author in his practice in Russia as a rule submitted all rolled and drawn bars and also certain castings of commercial brasses, tin bronze (copper with 8 per cent of tin and about 0.09 per cent of phosphorus), and aluminium bronze (copper with

FIG. 13. BODY OF ALUMINIUM TIME FUSE

9 per cent aluminium) for final heat treatment at 250 to 500 deg. C. (for castings at higher temperatures), according to the mechanical properties desired. Cold rolled rods (also some castings) made of aluminium or its alloys were submitted to a final heat treatment at 450 to 500 deg. C. Thus to prevent deterioration all strained metals must be subjected to a final heat treatment at a certain temperature for each metal. The other methods of removing initial stresses were not mentioned simply because the writer never applied them in his practice and can say nothing positively.

FIG. 14. DECAYED SPOT IN FIG. 13 AT 4 MAGNIFICATIONS

Concerning season cracks in brasses it may be pointed out that according to the researches of Professors Carpenter and Edwards we might expect a transformation

[12]"The Prevention of Season and Corrosion Cracking of Brass Artillery Cases by Special Heat Treatment," by W. B. Price, *Proceedings*, American Society for Testing Materials, 1918, Vol. XVIII, Part II, pp. 179-188.

of β crystals into brittle α crystals[19] to occur in certain brasses under certain conditions.

Proper Manufacturing Procedure for Aluminium Parts and Their Composition

In many countries parts of time fuses are now made from aluminium which contains a little copper and other metals, so that in reality it is a high-aluminium alloy. Possibly, however, copper causes aluminium to be less susceptible to the action of chemical reagents and to decomposition, as defined above. The facts and theories described offer sufficient basis for judging the best manufacturing methods for aluminium parts of time fuses.

Time rings, for instance, which are used in the assembly of the fuses, are flat disks with an open circular powder groove. These rings may be made according to one of the following main methods:

1. Cast and then stamped one way or the other to final dimension.
2. Cast and stamped, leaving in the powder groove sufficient stock for finishing in the milling machine.
3. Cast and compressed without powder groove, which is then milled out.
4. Round rods cast, cold rolled, rings sawed off and finished on machines.

FIG. 15. DECAYED SPOT IN FIG. 13 AT 80 MAGNIFICATIONS

5. Round rods cast, cold rolled, annealed, rings sawed off and finished on machines.
6. Round rods cast, hot rolled, rings sawed off and finished on machines.

Prevention of Decomposition

In regard to prevention of possible decomposition and self-destruction, methods 5 and 6 are, in the writer's opinion, the best. As regards composition it may be pointed out that after many experiments it was found that the best rich aluminium alloy for the time fuses is aluminium with 2.5 per cent to 2.9 per cent of copper.[20] Alloys containing more than 3 per cent of copper are too brittle to be cold forged.

All Russian 22-second aluminium time fuses for the last 11 years in Russia and also in this country were made of this alloy. Although it was very well known that magnesium considerably ameliorates rich aluminium alloys, the writer failed to obtain good results with this element because, first, he couldn't get at that time solid magnesium and was compelled to experiment with magnesium in powder or with small pieces, and,

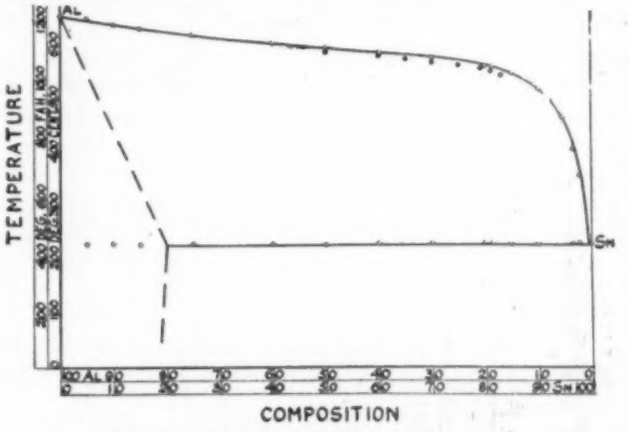


FIG. 16. EQUILIBRIUM DIAGRAM FOR ALUMINIUM-TIN ALLOYS, FROM GULLIVER

second, in rare cases when he succeeded in keeping magnesium within alloy the latter was rather brittle. For the same reason he failed to manufacture duralumininium.

Accelerating Effect of Tin on the Decomposition of Rich Aluminium Alloy

This effect was illustrated in Figs. 13, 14 and 15, showing the decomposition of tin-bearing aluminium alloy. It should appear that such a disintegration occurred not only in such a short time[21] (about eight years) but was to be found only with the above-mentioned time fuses made of an alloy: aluminium with 1.80 per cent of copper and 3.3 per cent of tin.

According to the accompanying equilibrium diagram, Fig. 16, aluminium-tin alloys belong to the class which does not form chemical compounds and when cooled quickly they contain more or less of crystals of nearly pure tin. If there is present free tin in an alloy, we can expect all the phenomena which accompany the decomposition of pure tin. Investigating this question further, we conclude that since pure tin can be found in binary, ternary, or multinary aluminium alloys in its unstable condition, then even a very small addition of tin to the alloy may serve as a source of the "plague." Furthermore, such a small quantity of tin, while decomposing itself, may catalyze decomposition in the other component metals. In this way, tin acts as a poison toward its neighbors.

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[19] Although according to O. F. Hudson we have to deal here with a polymorphic change β into β_1. See "The Critical Point at 460 deg. C. in Zinc-Copper Alloys." *Journal*, Institute of Metals, Vol. XII, 1914, pp. 89-99.

[20] It should be noted that this alloy, like other rich aluminium alloys, generally develops some troubles in machining because of the presence of small black particles, which are so hard that the best tools are broken immediately upon touching them. Many experiments were made by the writer with different methods of molding and casting, with the result that this important problem was not solved. Probably these particles are some hard form of carbon, or a chemical compound of carbon with silicon, or of silicon with aluminium. In any case this problem is open to investigation.

[21] It is to be remembered that Russian time fuses are stored in hermetical metal boxes.

The objection may be raised to the application of the aluminium-tin diagram to the ternary alloy aluminium-tin-copper. But in the aluminium-copper equilibrium diagram, Fig. 17, we have a chemical compound or solid solution, so that really there would not be any free copper in the composition used in the fuses which decomposed. Comparing the results of these two diagrams, we may deduce with reasonable certainty that even with the ternary alloy we may expect free tin on quick cooling and without careful annealing.

Therefore, although a small addition of tin to aluminium alloys is very attractive, as it renders the metal very satisfactory for machining, even without a lubricant, and in spite of the fact that small quantities of it may be dissolved by careful annealing this element

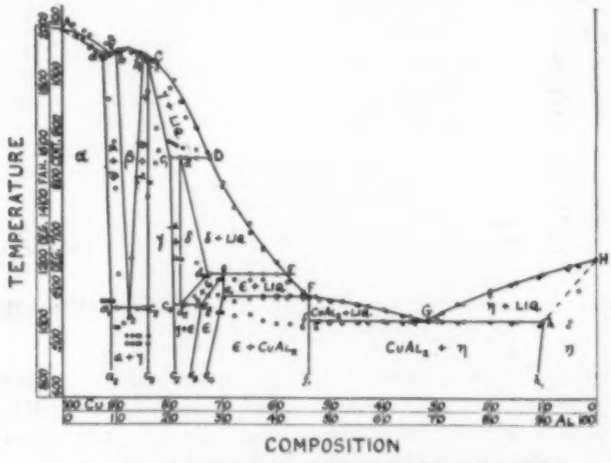


FIG. 17. EQUILIBRIUM DIAGRAM FOR COPPER-ALUMINIUM ALLOYS, FROM GULLIVER

was always avoided and, in the author's opinion, should be avoided when the articles must be kept for a long time, and particularly when cold working is to be used in their fabrication.

As regards a certain contradiction existing between the aluminium-tin alloy solidification diagram which is shown here and the writer's explanation it might be mentioned that at the time when the writer observed disintegration to take place in the aluminium parts of the time fuses considered, he had in mind Portevin's statement[22] in which he wrote in very positive terms that for aluminium-tin alloys there exists neither a chemical compound nor a solid solution.

In the meantime microscopic examination proved, as it was thought, that pure tin occurred in the network and in some spots on the grains and, as is mentioned above, the writer explained the disintegration of this metal as being due to an allotropic modification of the tin in which the tin assumed the brittle form and facilitated disintegration in two ways: (1) Say like bismuth in case of its alloy with copper, where each ductile crystal of copper is surrounded by a weak and brittle envelope of bismuth. (2) As a catalyzer.

Thus the writer explained this phenomenon, but if we have here a solid solution and not pure tin, then his interpretation is incorrect and we must seek some other explanation. Most of these facts and their interpretations are very well known, since they have repeatedly been stated in the literature and if in spite of this the author has ventured to repeat them again it was only in order to bring them together with some of his own observations.

Bureau of Standards,
Washington, D. C.

[22] "La présence de l'horizontale eutectique à 229° C. sur toute l'étendue du diagramme montre, qu'il n'existe ni solution solide ni composé défini, à moins cependant que ce dernier ne se forme très lentement. La constation qu'un alliage à 50% Sn maintenu cinq heures constamment agité à 710°–720° sans que cela modifie la courbe de refroidissement rend cette dernière hypothèse improbable." "Aluminum étain," M. A. Portevin, *Revue de Metallurgie*, 1908, 5, pp. 292-293.

A Correction

In the first installment of this article, published in this journal on March 15, a typographical error confused the sense. On page 281, first column, seven lines from the bottom, the sentences should read: According to W. H. Bassett, with wrought brasses in the α phase, the cracks always pass between the crystals. When both the α and β phases are present, the cracks pass through the beta.

War Trade Board Rulings

Importation of Dyestuffs.—The War Trade Board announces that hereafter all applications for licenses to import dyes or dyestuffs must be accompanied by a statement giving complete specifications of the character of the dyes or dyestuffs proposed to be imported. A supplemental information sheet, procurable from the Bureau of Imports, Washington, or from any branch office of the board, should be used for this purpose.

Importation of Ferromanganese and Spiegeleisen.—The restrictions heretofore existing upon the importation of ferromanganese and spiegeleisen have been removed and licenses to import these commodities will now be issued freely when the applications are otherwise in order. Importation of these commodities from the United Kingdom, France, Italy, Belgium or Japan, or from their possessions, protectorates, colonies or dominions, may now be made under General Import License PBF No. 34.—W. T. B. R. 674.

Disposal of Government Spelter

Tentative arrangements for the disposition of the War Department's surplus stock of spelter were made at a conference held in the office of the Director of Sales, which was attended by War Department officials and a committee representing the American Zinc Institute. A complete report was presented by the Government, the figures of surplus shown being considerably less than anticipated by the members of the committee, and it was arranged that the War Department would dispose of its surplus spelter through the zinc committee as representing the producers of zinc. This arrangement will tend to relieve any situation which might arise in the industry from the sale of this property by the War Department itself.

New General Import License

A general import license similar to PBF No. 34, but covering imports into the United States from Mexico, Cuba, Haiti, Santo Domingo and all countries of Central and South America, except British and French possessions, has been issued by the War Trade Board. Individual licenses are required for nitrate of potash, rubber and tungsten ore, in addition to the items mentioned under PBF No. 34 (see page 319), with the exception of ferromanganese and spiegeleisen.

Bituminous Roofing Materials and Construction—I

Genesis of the Roof—Importance of Incline, Types of Roofing Adopted: Flat Roof, Built-Up Felt and Pitch—Roofing Pitches, Weathering Properties—Felts, Sources, Processes of Manufacture

By GEORGE LANDIS WILSON

ROOFS, as developed in the progress of civilization, originally were provided with faces which consisted of overlapping units laid together on an incline so as to break joints with the outer and lower edges toward the drainage point, and each unit projecting beyond the contiguous higher units. Grasses and small twigs commonly known as thatch, slates, flagstone and tiles, shingles made of bark, wood and various composite materials are examples of such facings. All of these required decks, or the equivalent, set at an angle from the horizontal sufficient to direct water to a point where it could not flow back or pass down through the several layers of units and permit leakage through the roof.

For this reason roof design became a problem in the intersection of the faces of pyramids, plinths and polyhedral contours in endless variety.

In the course of time sundry materials in the form of impervious continuous membranes were used as substitutes for the various scale-like applications of material. These were metals, made continuous by the use of soldered seams, continuous membranes built up out of layers of fabric or felt, alternating with various pitch or other water-resisting compositions, and prepared roofings, factory made out of felt saturated with waterproofing materials having the seams cemented together with similar substances. As the use of the various membranes progressed the roof decks used with them were given less slope for the reason that much labor and material are saved when the intricate framings and decks are abandoned, until the "flat roof" became the standard and usual type of construction in many places.

Roof Incline Has Important Bearing

It will be seen that the incline of the roof has a most important bearing in selecting the type of roofing best suited for a given structure. Thus, in general, bituminous roof coverings are divided into two classes; first, those employing a continuous layer impervious to water, the same as in the case of membrane waterproofing used to protect against water pressure below the ground level; and second, those employing separate overlapping units which shed water, as do shingles, tile, etc. While there is a considerable overlapping in the practical application of these two general types, the impervious continuous layer being applicable to any incline, there is a minimum incline below which shingle type is not practicable.

Prepared roofings in roll or sheet form should, perhaps, be considered as a third class by reason of their wider adaptability to almost every roofing condition, although it is generally conceded that they are more serviceable when used on inclines exceeding 2 in. to the foot than on anything less, and that 1 in. to the foot is the minimum, except where unusual and impracticable precautions are taken to avoid exposed nailings and protect against leaks under the exposed laps.

A fundamental to be borne in mind is, in proportion as the roof incline is reduced the greater should be the water-resistant power and assured continuity of the roof covering.

As this article treats only of bituminous roof coverings, it will discuss separately, first, the "built-up" type particularly suited for flat roofs; second, prepared roofings, either in roll or shingle form, particularly suited for roofs of steeper incline.

Conclusive Tests Not Available

Wooden shingles, slate, clay or cement tile, galvanized iron and tin are materials regarding which there is an abundance of general as well as technical information in such form as to be readily available for any one interested in specifying or buying roofing; but such is not the case regarding roofings in which bitumen—coal tar or asphalt—is employed, for the reason that bitumen, which is a hydrocarbon, is the most complex substance with which chemists have to deal. There are probably more than forty different natural sources of bitumens used regularly in the manufacture of roofing, each varying to a more or less degree from the other in chemical or physical characteristics, and each capable to a greater or less degree of mixture with some or all of the others, and each supply, or combination, because of some commercial, physical or chemical characteristics, having its own support among the manufacturers of bituminous roof coverings.

Furthermore there has been no series of tests standardized and accepted as proving that a particular piece of roofing made from a certain material and by a certain process is more suitable for a given purpose than another piece of roofing made from a different material or by a different process. Also, most of the tests that have been suggested are workable only when conducted in a well equipped laboratory, and by some one thoroughly familiar with bitumens and also with their practical uses. Therefore such tests are not available for the average buyer of roofings. As a result each manufacturer has been free to make such claims for his own particular product as his judgment or business necessity has suggested, in most cases without danger of positive and conclusive contradiction; hence there have been large amounts of bituminous roofing materials sold on the basis of claims of general or particular merit which had no justification.

In spite of this condition, which is inherent in the

business and exists today to as large an extent as at any time in the history of the art, the industry has grown during the past seventy years from nothing to such importance that its products annually are used to cover a larger roofed area than are all other types of roofing combined, and in the United States alone represents an investment variously estimated at from $40,000,000 to $60,000,000. This of itself is evidence of the inherent merit of bitumen as a roof covering. The following is offered with the hope that it will in some degree assist the buying public to obtain better value than has been generally the case in the past. We would not presume at this stage in the development of the industry, or of the technical knowledge regarding its supplies, processes and products, to provide an infallible guide.

Functions of a Roof

On the part of the buyer mistakes of judgment, aside from those due to lack of technical knowledge of the commodity, can be traced to confused thinking regarding the results really wanted. Hence it is desirable first to set out clearly the functions of a roof in combination with its joinings and flashings, which serve to complete the connection with projections and walls.

At this time it is also well to remember that every building, except it be a monument, is primarily erected to provide shelter from the weather, and the basic element in such shelter is a serviceable roof. Everything else is really collateral to the principal aim.

Couple with this the fact that in any community the cost of the roofing material used averages less than 1 per cent of the total cost of the finished structures, and misguided effort to make petty savings by cutting either quantity, quality or workmanship here look ridiculous. From the standpoint of the owner, whose entire investment is safeguarded in its most important aspect at such a small relative cost by the roof face, and also of his legitimate agents, the architect and constructing engineer, or contractor, employed and held responsible solely because they are presumed to be skillful and discriminating in selecting that which will be most useful to him, the roof is no place to try experiments. The possible money saving is trifling, while the probable expense, in the event of failure, is large.

Table No. 1—Reasons for Applying Roof Faces, Joinings and Flashings.

(Stated in the usual order of consequence.)

1. To waterproof plane surfaces against rain, melted snow and ice.
2. To join plane surfaces to projections and walls so as to exclude driving rain and snow.
3. To care automatically or compensate for movement and cracks in decks and walls.
4. To protect the most exposed part of premises against spread of conflagration.
5. To provide means for blanketing fire in the building where it starts.
6. To prevent air leaks or drafts, caused by wind.
7. To provide a moderate degree of protection against heat and cold.
8. To provide a presentable architectural finish or uniform effect.

Brief Summarization

The means for accomplishing these results by the use of bituminous materials are briefly summarized as follows:

Table No. II.—Functions of the Substances Used in Bituminous Roof Faces.

1. *Bituminous Waterproofing Material:*
   (*a*) Held as a solid mass of saturant, absorbed in a sheet of felt and on its surface; and also used as a cement at the narrow laps of the sheets when laid. Or
   (*b*) Spread in layers between successive sheets of saturated felt widely overlapped, and also spread over the top to form a continuous membrane.
2. *Absorbent Felt or Textile Used:*
   (*a*) To retain in place greater quantities or more layers of bitumen pitch of suitable softness than would stay by itself or if mixed with pigments or fillers. And
   (*b*) To provide a body of material having sufficient tensile strength and extensibility to bridge all normal cracks and similar changes as they occur from time to time, due to settlement or curing of the walls and decks.
3. *Top Finishing Material:*
   (*a*) To retain an abnormal amount of bitumen pitch in the most exposed place.
   (*b*) To withstand the wear and action of the elements and also abuse by men.
   (*c*) To provide a fire-resisting face to meet conflagration hazards.
   (*d*) To make an attractive, uniform appearance.
   (*e*) On prepared roofing, to supply a dry side, to prevent adhesion and insure easy delivery from the roll when used. Materials so used are cement concrete, bitumen, mastic, vitrified brick, flat tile, small slates, gravel, slag, crushed rock, crushed slate, sand, asbestos fiber, mica flakes or powdered soapstone.

Waterproofing Not a Simple Matter

It is not so simple a matter as it appears to provide a roofing material which will remain permanently waterproof. All viscous materials contain a proportion of oils or oil-like matter having a tendency to evaporate slowly when exposed to the air at ordinary temperatures, precisely as water with a boiling point of 212 deg. F. evaporates rapidly at a temperature of 60 deg. Many of these substances become relatively hard, assuming a crystalline form when they become cold.

The strains placed upon roof faces as the result of extremes in temperature between summer heat and winter cold are evident. In those cities of the U. S. north of 40 deg. latitude, roof surface temperatures as high as 150 deg. above and as low as 20 deg. below zero, F., are usual. It is impossible to make the coefficients of expansion and contraction, due to variable temperature, the same for roof surfaces, roof decks and roof enclosures. The roof face is called upon to provide the element of compensation due to the fixity of construction in the building of which it is a part.

Roofing Pitch

For this reason it is desirable that any bitumen used for roofing materials shall be of a nature that will fuse or run together at a temperature of few degrees below the maximum temperature to which it will be subjected during hot weather. At the same time this fusing quality must be obtained through the presence of oils which are not easily evaporated under conditions of use. The natural oils left in coal-tar roofing pitch during the process of distillation with scientific exactness, to insure a melting point of 140 to 150 deg., as desired, attain these results in an ideal manner. It is difficult to secure equal results when foreign oils are added to bitumen bases. They mix so as to reduce general melting points at relatively high temperatures, say 250 to 400 deg. F., but they do not blend so as to insure the restoration of lesions liable to occur during cold weather.

The causes behind these conditions encountered in practice are indicated by a view of the components in pitch.

Table No. III—Elements in Bitumen Pitches.

1. Gums, which in the last analysis are in the nature of fossilized vegetable tars.
2. Oils which serve as solvents for the gums, and are stable at temperatures less than 150 deg. F.
3. Solvents, which evaporate very slowly at various temperatures lower than 150 deg. F.
4. Fixed mineral matter, composed of infinitely small crystalline units, is usually present.
5. Some asphalts carry wax which is different from gums, because of its coarse crystalline formation, trifling tensile strength and marked inflammability. Such elements are eliminated from coal tar in the making.
6. Traces of sundry alkaline bases which, with the addition of small amounts of water and moderate heat, develop into reagents that attack oils and gums are found in some asphalts. Processes of coal-tar distillation divorce these materials from coal-tar pitch.

Destructive Reactions

In this connection it must be remembered that the water deposited upon roofs is soft water ready to take up promptly in solution every impurity it finds. Roofs are most numerous in places where there are industries and population. The fuels most commonly used in such centers are constantly delivering into the air and depositing upon all the roofs a variety of acid bases which are readily soluble in water. The wastes of civilized life and the ordinary processes of nature constantly produce a supply of micro-organisms which multiply rapidly when water or mere moisture is present and become the source of fungi and molds that cause decay. Weather Bureau records show that rainfall on most occasions is very small in amount, often merely a trace. This means that water sufficient to dissolve all the impurities is frequently present but as a rule not in sufficient quantity to provide a real flow or a flooded washing effect. This chain of circumstances, properly considered, enables one to picture the destructive reactions which repeatedly take place if roofing bitumens contain any susceptible impurities or are so deficient in quantity as to permit any part of the felt to absorb water.

Table No. IV—Some of the Sources From Which Roofing Pitches Are Derived.

1. Tar by-product from coal remaining after production of gas.
2. Tar by-product from coal remaining after the production of coke.
3. Tar produced in the manufacture of water-gas and oil-gas.
4. Deposits of native asphalt which are cut in various oils.
5. Heavy residuals from distillation of petroleum crude oil having asphalt base.
6. Heavy residuals from distillation of petroleum crude oil having paraffine or mixed base.
7. Heavy by-products from treatment of oil-bearing shale rock, lignite or peat.
8. Tar by-products from refining of vegetable oils.
9. Tar and resins from tree exudations and wood-distilling processes.

The methods of treatment to which by-products and residuals are subjected produce pitches of various characteristics. For example, some asphalts are made by oxidizing and polymerizing the hydrocarbons from petroleum sources through the process of blowing heated air or air with steam through the mass for a considerable period of time. Similar treatment with sulphur has been used. The same basic residuals are sometimes concentrated by the mere application of steam heat. The results are not identical. When heated to proper temperature they are all readily absorbed by sheets of felt, but they do not present equal weather-resisting qualities.

The foregoing table does not include all of the possible origins of pitch. Those mentioned are important, and the variety serves to suggest the diversity in the nature of the products which spring from them. Couple with this basic natural variations in the materials used as a starting point, the changes in hydrocarbons caused by heat at different temperatures and during different periods of exposure, the varying degree of skill possessed by operators, or the entire lack of it, the degree of capacity and willingness to test raw materials before refinement or distillation, and the suitability or degree of completeness in the equipment at the works where the pitch is prepared for the market, and there is reason enough to recognize the value to the buyer of established brands sponsored by reputable and responsible manufacturers.

Bitumen as used in saturating felts for roofing must be brought to a state of viscosity which permits it to penetrate the felt. The best method of securing this result is the application of heat, provided the melting point of the pitch is low enough so that the degree of heat required does not damage the felt fabric. Attempts are made to accomplish the result by the use of oils or solvents in the nature of thinners, following the general practice of the varnish trade, so as to secure a saturating material which will penetrate and also set up at normal temperature. This process requires the use of some thinners which evaporate rapidly, and others which evaporate slowly, with the result that the substance of the bitumen becomes cellular and finally impaired to such an extent that the sheet becomes hard and brittle. There are a number of foreign solvents which are effective enough when considered merely as thinners or as waterproofing materials in themselves that are unsuitable for roofing, either because of relatively high inflammability, absence of gum characteristics, lack of synthetic quality, disposition to carbonize at low degrees of heat or readiness to evaporate.

When skillfully used, oils and solvents which have such affinity for the bitumen treated as to form a true combination (instead of a mere mixture) solely for the purpose of lowering the melting point of the bitumen and insuring fixation at normal temperature are serviceable, provided they are stable.

Bitumens used as coatings for prepared roofings and for cementing together and surfacing several layers of felt as applied on a roof surface are generally of a higher melting point than bitumens used as a saturant, but they must also be liquid when used and become solid in a relatively short time at atmospheric temperature. The higher melting point required is obtained either by using different bitumens as a base, or by distillation or oxidation, or by the addition of finely ground inert mineral in the form of silica, slate flour, gypsum, powdered lime, etc. The addition of the inert material is generally for the purpose of lessening the cost, and such mixtures are not as serviceable as pure bitumen except for special purposes outside of the scope of this article.

Felt originally was a specific term used to designate a stuff made of matted wool and hair worked into a compact substance by rolling or pressing and held together by a size made from a weak solution of glue, the dregs of wine or any other convenient viscous material.

Later it became a generic term also applied to any relatively thick sheet which is of comparatively open structure when measured by the standards set up by practice in the paper and cardboard trades. Thus carpet felt, building felt and deadening felt came into regular use at a very early date to prevent the wind from blowing through houses. It was supplied in rolls, as distinguished from flat sheets like paper and strawboard, so naturally fell into a class by itself.

In the United States the history of felt base roofing dates from its employment in gravel roofing, which began about 1845. Naturally the roll felts common in the building trade were used when there was need for a medium to hold a saturation of tar, preliminary to its early application with layers of pine pitch to make a roof face. Coal-tar pitch was first used about 1850. The name "saturated roofing felt" has persisted. The common characteristic of all the felts when considered for saturation lies in their open texture, freedom from inert material and the true absorbent qualities of their fibers, which are truly impregnated and not merely coated by the saturating material. For example, water permeates a body of sand or gravel, yet drains out of it freely and completely; while water impregnates or saturates a sponge or mass of fiber and is removable only by evaporation.

Table No. V—Various Materials Used in Roofing Felts.

1. Animal and vegetable fibers, as wool, cotton and linen, obtained from the maceration of rags and rope.
2. Old paper, jute, flax-tow, hemp, etc.
3. Linters and mill fibers of the waste class.
4. Fibrous wood products obtained by the sulphite and soda process.
5. Mineral fibers, usually of the asbestos series, but sometimes blown slag, mostly non-absorbent.
6. Clay, powdered limestone or like earths used as fillers and weight-makers which absorb little saturant and contribute no strength.
7. Sometimes woven textiles are used as reinforcement sheets.
8. Rarely, wire mesh, wire strands and fiber cords or strings are used for reinforcement.

Processes of Manufacture

The processes of manufacture in the production of roofing felts follow closely the processes established in the writing and wrapping paper industries. However, sorting, cutting, dusting, boiling, washing and beating are not carried so far, and bleaching is unnecessary. The machine used for changing the pulp-like mass into sheets is usually of the cylinder type, although the Fourdrinier type is sometimes used. Press rolls are not set tight, drying cylinders are ample in number and smoothing rolls provide all the finish the dry felt requires. The production of felt for saturating purposes requires a fine balancing of absorbent qualities, tensile strength and durability. "Wool felt" is a misnomer. Felt 100 per cent wool would be entirely unsuited for roofing purposes. A high grade roofing felt contains from 50 to 75 per cent of cotton fiber, a negligible percentage of wool, and oftentimes old papers are used to a limited extent.

Felt when saturated and then surfaced with bitumen becomes roofing and is known as prepared roofing or ready roofing, or felt base shingles, depending on whether furnished in rolls or shingle form, and is a finished product ready for use by itself as a roof covering. Felt when saturated with bitumen but not surfaced must have bitumen used with it when it is applied as a roof covering. While saturated felt by itself will shed water, it is not what would be termed waterproof and will disintegrate rapidly when exposed to the weather. The standard weight of saturated felt for roofing purposes is 15 lb. to the 100 sq.ft., with an allowable variation of one pound either way. Approximately 60 per cent of this weight is saturant and 40 per cent felt, but these percentages vary depending on the viscosity of the saturant and the absorbent qualities of the felt. There are several other weights of felt manufactured because of demand to meet competitive conditions, but there is no reason for any other weight than 15-lb. saturated felt for roofing purposes.

Burning Lime in a Gas-Fired Continuous Kiln

By W. D. Mount

THIS paper is presented for the purpose of drawing attention of lime manufacturers to a system by which lime can be burned economically in a kiln 8-foot diameter with a capacity of 25 tons per day. The ratio of coal to lime is 1 to 5 or 6, depending on the quality of the coal. Cost of repairs per ton of lime is lowered.

The conversion of calcium carbonate to lime is a chemical process which may be conducted without any chemical knowledge, and with but a moderate amount of technical skill. As the carbonate is decomposed at a red heat, it is apparently only necessary to apply the heat for a short period, and the result is lime, regardless of considerations of economy.

"Every step and every factor, however, in the operation of lime burning has a definite significance, and the production of high-grade lime with high-grade economy is as truly a technical process demanding skill and knowledge as any other chemical manufacture. There is need of trained chemists and engineers in this industry to put it upon a distinctly scientific plane."[1]

As every step and factor in the process have a definite bearing on the final outcome, they must be under complete and constant chemical control. Therefore, it is not only necessary that such control be provided, but the design of the apparatus must be of a character that the control can be made effective; otherwise, it will be impossible to realize that continuity of operation and co-ordination of the various factors, so essential to uniformity in quality and quantity of output and the attainment of the highest efficiency and economy.

Engineering Design and Chemical Control Essential

It is doubtful if the salary paid a trained chemist could be invested to better advantage, or be more productive of desired results in any industry than in the manufacture of lime and lime products. However, as already indicated, it is not a problem for the chemist alone, but his work must go hand in hand with that of the engineer. Chemical control cannot be effective in the highest degree unless the design is of a character

[1]Geological Survey of Ohio Bulletins 4 and 5, Orton & Peppel.

to permit the regulation of all those factors having a direct bearing on the final result.

The foregoing statements lead naturally to a consideration of problems of design, preliminary to which, however, it is well to call attention to certain specific factors having a direct and important bearing on the operation of the process. It seems to be the accepted opinion, backed by many years of practical experience, that wood, both technically and as regards quality of product, is the most desirable fuel. It is not my intention, however, to consider the merits of a fuel now unattainable, or at least practically so, but to accept without discussion the most generally available fuel approximating the good qualities of wood, namely, producer-gas made from bituminous coal low in sulphur, in a modern producer-gas machine, so located and operated as to deliver to the kilns the maximum number of B.t.u. per cubic foot of gas. Moreover, that coal will be used, regardless of price, which will give the greatest number of pounds of lime for a dollar.

It would seem axiomatic that a kiln of the shaft type, other things being equal, will have the highest fuel economy when operated so as to be cold at the top and cold at the bottom, and that its capacity, under these conditions, will be greatest when discharging continuously.

"Temperature of burning is an important factor, both in the quality of the product and in the economy of production. Economy in manufacture requires that the temperature of burning should not be greatly beyond that needed for the complete removal of carbon dioxide. . . . The time required for slacking limes burned at different temperatures shows clearly that the sensitiveness of quality of the lime is materially affected by any great overheating."[2]

Importance of Temperature Control

In the use of heat it is necessary, not only as effecting the reaction, but on the grounds of economy, that definite control of temperatures be possible, and in many industrial operations control must be effective to within a few degrees in order to insure the greatest success. Therefore, it seems essential in a well designed kiln for producing lime, that suitable provision should be made for determining and maintaining the proper temperature necessary to the production of the best quality of lime possible from the stone to be burned. Overburning from too high temperatures, or the production of core from insufficient heat are alike undesirable qualities. Fortunately the burning of calcium carbonate to lime is not like some other heat operations, in that a fairly wide range of temperatures is permissible without materially endangering the quality of the product; though from motives of economy, as affected by kiln capacity, it is desirable to approach as near as possible the safety limit of the maximum allowable temperature as the quality of the product will admit. Hence the importance of close regulation, regardless of the considerable range of temperature within which the kiln may be safely operated.

The question of draft is important, not only as affecting the capacity of the kiln, but from the standpoint of economy. Induced draft is preferred, as it is independent of height of kiln, and size of material charged, and can be controlled by the operator in charge.

[2]Geological Survey of Ohio Bulletins 4 and 5, Orton & Peppel.

When de-carbonizing has proceeded to the point where all gas has been expelled, the lime should be promptly removed from the zone of intense heat into the cooling zone; first, to prevent "dead burning" and recarbonization, due to exposure to the combustion gases; and second, that the cooling may be progressive following the principle of the counter current, the hot lime giving up its heat to the incoming air for combustion.

The removal of the lime from the reaction zone to the cooling zone, and its final discharge from the kiln should be continuous. This is an important feature of the design, inasmuch as the discharge mechanism will bring about a slight, but perceptible, movement through the entire charge in the kiln, tending to stabilize the draft, prevent clinkering and holding up of the charge, and improving the life of the brick lining.

Time Required for the Reaction

The length of time required for the limestone to pass through the reaction zone will depend on several factors:

First: The size of the limestone blocks fed to the kiln. The smaller the blocks the less will be the time necessary for the heat to reach their center, other things being equal.

Second: The amount of pre-heating the stone has had, prior to reaching the reaction zone, as well as the kiln pressure.

Third: The nature of the fire, its volume and intensity, and its close regulation.

Fourth: Continuous movement of the stone through the reaction zone.

If a continuous stream of stone can be kept passing through the reaction zone at a rate that would insure the complete burning of the stone to lime, and no more, it would be of advantage to the quantity and quality of the product, for the reason that the constant movement would keep turning the stone, giving equal exposure on all surfaces.

Design of Continuous Kiln

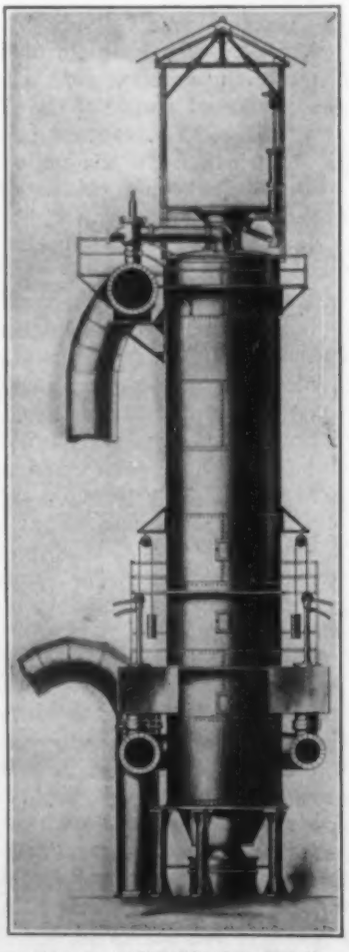
The design of the continuous discharge gas-fired kiln is not, as will be noted in the illustration, altogether a radical departure from the standard of the more modern kilns of the shaft type. Neither the use of producer gas, induced draft, nor the idea of cold lime from the bottom of the kiln are essentially new. On the contrary, these ideas have been tried with more or less success in the past. The principal characteristic of the design is a careful balancing of parts for the specific purpose of permitting that close chemical control, without which continuity of operation, uniformity in quality and quantity of product, and the highest efficiency and economy are impossible.

It may be assumed, without question, that uniformity in output presupposes a similar condition as regards input, and that the former cannot be safely predicated on variable conditions as regards the latter. Therefore, in addition to certain essential conditions, already indicated, we should specify stone of uniform size within prescribed limits, clean and free from dirt, and charged in predetermined quantities at regular intervals; close regulation of the draft, and quality of the exit gases and their temperature; also close attention to regulation of the temperature in the reaction zone.

For the purpose of description the kiln may be divided into three sections or zones, cooling, reaction and preheating. At the bottom of the cooling zone is located the continuous discharging mechanism, and at the top of the zone the inlet tuyeres, admitting the fuel gas from the producers to the reaction zone. The design of the tuyeres is important in order that a uniform distribution of the fuel gas may be insured throughout the mass in the reaction zone; otherwise, there would be a tendency for the gas to creep up the sides of the kiln, causing over-burning at the sides and under-burning or core in the center.

The reaction zone is encircled with three rows of peep-holes for observation. The couple of the recording pyrometer is located in the middle belt. The boundary line between the reaction and preheating zones is not, of course, very sharply defined, but it may be roughly assumed that the preheating zone is comprised within the limits of the upper half of the kiln, and the reaction zone the fourth next below.

Gas is admitted from the producers to the reaction zone through water-cooled balanced valves, easily regulated from the ground, where are located the temperature gages for each kiln. The continuous discharge mechanism at each kiln is driven from a common shaft, but can be stopped or started independently of the balance of the kilns in the battery. The speed of discharge is figured to 25 tons of lime per day of 24 hours, though means are provided for varying the speed of the common driving shaft. The top of the kiln is closed, and in the cover is located a hopper and charging belt, the latter raised and lowered by compressed air, and designed to give a uniform distribution of the stone over the top of the kiln, maintaining the surface level at all times, insuring an even distribution of the gases in the preheating zone. At the top of the kiln is also located the draft pipe for the exit gas, regulated by a valve of the same type as that used for the fuel gas.



GAS-FIRED CONTINUOUS KILN

The total height of the kiln to the level of the charging floor is 60 feet, and from the bottom of the cooling zone to the top of the preheating zone 48 feet. The diameter is 8 feet, maximum, inside the brick work. The stone is charged in uniform batches of 1000 pounds at regular intervals of 15 minutes, or 4 periods per hour, for a capacity of 25 tons per day. The draw is continuous, and can be arranged at any section of the bottom circumference where most convenient. The cold lime is removed in barrows or conveyors, for hydrating, storage, or direct to cars for shipment.

The preferred arrangement of the kilns is in batteries of six, with a producer-gas machine located midway of the battery. This combination, under proper control, will have a capacity of 150 tons of lime per day, with a coal to lime ratio of 1 to 5 or 6, depending on the quality of the coal. Four kilns of this type have been in constant service at the plant of the Farnam Cheshire Lime Company, Farnam, Mass., for a period of over five years, and are reported to have given satisfactory results in economy of operation, capacity and quality of product.

Roanoke, Va.

Strength of Commercial Liquid Glues

Most of the commercial liquid glues are manufactured from the skins, heads and swimming bladders of fish. Others are made by special treatment of the glue extracted from the hides, skins and bones of cattle; some for special uses are prepared from starch, from various natural gums, or from casein.

At the Forest Products Laboratory tests were made on a number of these liquid glues by B. A. P. inspectors, who found that they differ widely in strength. Some of them are so weak as to be entirely unsuitable for woodworking purposes, while others compare favorably in strength with the "hot" glues. The adhesive strength of the glues tested varied from less than 50 lb. per sq.in. to more than 3000 lb. per square inch.

Liquid glues may be tested by gluing together pairs of specially selected hard maple blocks, placing them in a testing machine, and measuring the force required to shear them apart. About 300 specimens, representing 26 different glues, have been tested in this way at the laboratory. According to the data thus obtained, a high grade liquid glue should have an average shearing strength of not less than 1700 or 1800 lb. per square inch.

In addition to uniform high adhesive strength, it is evident that certain other characteristics are desirable in a liquid glue. When spread upon wood surfaces, it should "set" and dry rapidly. In its container, it should remain fluid and workable at all ordinary temperatures. It should be elastic and shock-resistant. It should not be unusually susceptible to the action of high temperatures, high humidity, molds and bacteria.

The study gave evidence that the strength of liquid glue, like that of "hot" glue, depends largely upon its "body," or thickness, or, strictly speaking, upon its viscosity. Of 11 liquid glues examined, the thickest or most viscous glues showed the greatest adhesive strength.

German-Owned Shares Sold

The German-owned shares of the capital stock of the American Metal Co., Ltd., were sold at public auction by the Alien Property Custodian on April 7. Hayden, Stone & Co. of 25 Broadway, New York City, bought 36,344 shares for $4,850,160, while 562 shares of capital stock of the Compania de Minerales y Metals, a subsidiary company, were sold to Mr. H. W. McAnteer of the American Metal Co. for $57,000. Since none but American-owned companies were allowed to bid, 76 per cent of the stock is now in American hands.

Recent Chemical and Metallurgical Patents

Nitrogen Fixation

Nitrogen From Air.—Ammonia from cyanamide is combined with sulphur dioxide and water to give a concentrated solution of ammonium sulphite. When this is treated with air on the counter current principle, the oxygen converts the sulphite into sulphate, and by arranging the absorption towers in series, the oxygen is almost completely absorbed at a temperature of 70 to 75 deg. C. In this manner NOBILE TOMMASI of Basel, Switzerland, obtains a supply of pure nitrogen for the further production of cyanamide; 48.3 kilos of ammonium sulphite, containing 11.7 kilos of nitrogen, absorb 6.7 kilos of oxygen. The residual nitrogen, 22.4 kilos, is nearly twice that required to produce 48.3 kilos of ammonium sulphite additional, and is consequently sufficient to cover any losses in the manufacture of cyanamide, (1,295,635; Feb. 25, 1919; assigned to Usines Electriques de la Lonza of Gampel, Switzerland).

Separation of Alkali-Metal Cyanide From Hydroxide.—Alkali-metal cyanide made by passing nitrogen over a heated mixture of sodium or potassium carbonate and coke or charcoal is always contaminated with the oxide or hydroxide of the metal used. FLOYD J. METZGER of New York adds to this mixture sufficient water to convert any unchanged anhydrous carbonate into the decahydrate. A "treating solution" consisting of a water solution of ethyl, methyl or denatured alcohol, acetone or a similar solvent is used to dissolve the cyanide and hydroxide, the hydrated carbonate being insoluble in the mixture. By passing carbon dioxide into the resulting solution, the hydroxide is converted into carbonate, which separates out as the decahydrate. The filtered solution, after evaporation in a solvent recovery apparatus, yields pure alkali-metal cyanide in a dry state. (1,295,049; Feb. 18, 1919; assigned to Air Reduction Co.)

Ammonia From Alkali Cyanide and Ferrocyanide.—Cyanides are decomposed by steam according to the equation:

$$NaCN + 2H_2O = HCO_2Na + NH_3$$

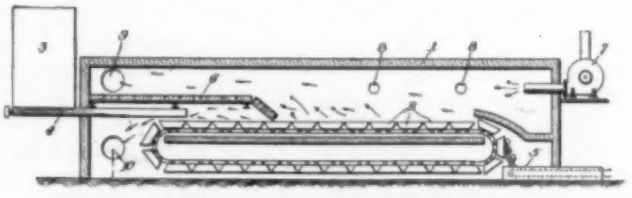
When, however, cyanide resulting from the process of fusing a carbonate with charcoal and iron is used, the yield of ammonia is poor. C. F. BIERBAUER of Kenvil and L. S. FINCH of Dover, N. J., dissolve the crude cyanide as rapidly as possible by blowing the powdered material into a tank equipped with a water spray and agitator. The solution is immediately filtered on a continuous rotary filter. In this manner the formation of ferrocyanide is reduced to a minimum. The solution is heated indirectly by steam at 125-lb. pressure in a tank provided with pressure relief valve which is set to operate at 50-lb. pressure. Pressure in the tank is thus maintained at 50 lb. while the ammonia and water vapors which pass through the relief valve are condensed, a portion of the water condensed being returned to the tank so that the final product is a concentrated ammonia solution. When the crude material contains an appreciable amount of ferrocyanide, the cyanide present is changed into ferrocyanide by digesting with finely divided iron, and the whole decomposed, after filtering, in a similar apparatus using from 80 to 150 lb. pressure. (It would seem as though the mixture could be treated without the conversion of cyanide to ferrocyanide, by first decomposing the cyanide at 50-lb. pressure and subsequently increasing the pressure by means of the relief valve, so that the ferrocyanide would be decomposed.) (1,295,262 and 1,295,293; assigned to the Hercules Powder Co.)

Nitric Acid From Ammonia.—Although ammonia will not burn in air even in the presence of a catalyzer, unless the latter is heated to from 600 to 700 deg. C., WALTER S. LANDIS of New York has found that with air so enriched as to contain 30 to 40 per cent oxygen, external heating of the catalyzers is unnecessary, and the reaction proceeds according to the equation:

$$4NH_3 + 5O_2 = 4NO + 6H_2O.$$

The nitric oxide is converted into nitric acid by known methods. The necessary oxygen may be obtained from liquid air, and the nitrogen used to make cyanamide as the source of ammonia. (1,292,814; Jan. 28, 1919; assigned to Frank S. Washburn.)

Manufacture of Calcium Carbide.—A method for producing aggregates to be used as the charge in calcium carbide furnaces was patented by FREDERICK M. BECKET of Niagara Falls on April 27, 1915 (1,137,567). Lime was mixed with bituminous coal and the aggregates formed in a by-product coke oven of the ordinary type. His present inventions deal with a special type of furnace, in which heat losses are reduced to a minimum by burning the limestone and coking the mixture in a single operation. The hot gases from the limestone give the heat necessary for the coking operation, while the volatile products from the latter, after passing through a by-product plant, are used as part of the fuel for burning the limestone. A mixture of ½-in. grains of limestone and rich bituminous coal, in the approximate proportions of 100 to 62, is fed from the storage bin 3, by means of a mechanical device 4, into the cars 2, which form a continuous chain. The furnace is heated by the burners 7, 8, but during the first stage of the passage through the furnace, the material is protected from the direct action of the flame by apron 6. As a result, the coking operation is practically completed during this period, the volatile products escaping through opening 10, to be used as indicated above. In the open portion of the furnace, the limestone is converted into lime, without, however, injuring the aggregates already formed. The fully converted charge is conveyed, by means of 5, to the carbide furnaces with as little loss of heat as is practicable. (1,292,386 and 1,292,387; Jan. 21, 1919; assigned to Union Carbide Co.)



METHOD OF PREPARING CHARGE FOR CALCIUM CARBIDE FURNACE

Hydrometallurgy of Copper.—Fig. 1 represents a flow sheet of a process devised by W. N. ROSSBERG and A. E. SHERIDAN of Butte, Mont., for the recovery of copper from sulphate solution. This solution should be free of considerable quantities of iron before entering the absorption tower. This may be done by air agitation with copper oxide and then filtering. Precipitation by H_2S as cuprous sulphide requires but half the amount of reagent necessary otherwise, and while effected at atmospheric temperature and pressure, is considerably facilitated at 160 deg. F. and 40 lb. per sq.in. The reactions are complicated and not determined; but may be summed to

$$2\,CuSO_4 + H_2SO_3 + H_2S + H_2O = Cu_2S + 3H_2SO_4$$

Thus acid is generated as well as recovered. The prepitation may also be effected by adding powdered CaS to a solution previously saturated by SO_2 as follows:

$$CaS + 2CuSO_4 + H_2SO_3 + H_2O = Cu_2S + CaSO_4 + 2H_2CO_3$$

which reaction is also facilitated by heat, pressure, agitation and free acid. The patentees point out that this process can be utilized to purify zinc sulphate

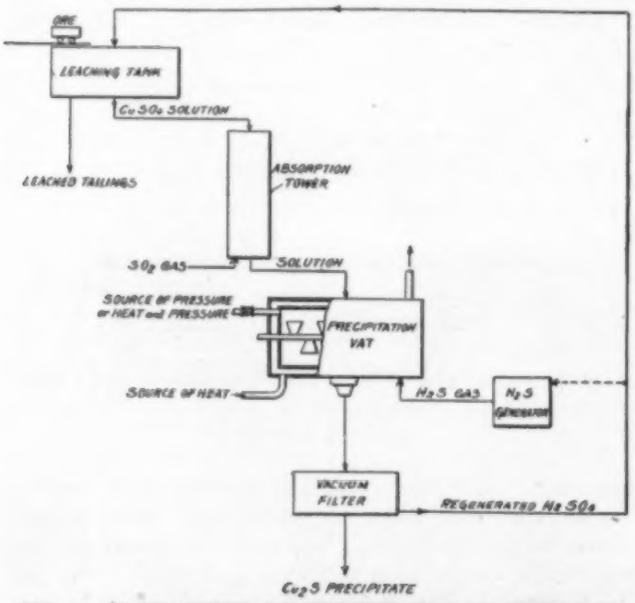


FIG. 1. FLOW SHEET OF PROCESS FOR RECOVERY OF COPPER FROM SULPHATE SOLUTION

solutions from metals of the second group. Its advantages are that it generates acid, requires a minimum of H_2S, gives a high-copper precipitate, and gives a final solution substantially free from H_2S, any excess being neutralized by the SO_2 present. (1,292,075; Jan. 21, 1919.)

Manganese Dioxide Depolarizers.—While pyrolusite, or natural manganese dioxide, is used as a depolarizer in large batteries of the Leclanché type, the artificial product is more efficient for small dry batteries, especially those used in flashlights. For the preparation of the latter, two reactions have been used:

$$Mn(NO_3)_2 + MnO_2 + 2NO_2 \qquad (170°\ C.)$$
$$2MnCO_3 + O_2 = 2MnO_2 + 2CO_2 \qquad (300°\ C.)$$

The low melting point of manganese nitrate causes the product of the first reaction to appear in the form of a hard solid mass, which, even after grinding, is inferior to the powdered mineral. The second reaction does not go to completion and the carbonate remaining impairs the shelf life of the cell. By combining the two methods, MORDUCH L. KAPLAN of Brooklyn overcomes these difficulties. Manganese carbonate is heated above 300 deg. C. for several hours, yielding a product containing approximately 70 per cent MnO_2. Treatment with nitric acid converts the unchanged carbonate and acid-soluble impurities into nitrates. The mixture is heated to the temperature at which the $Mn(NO_3)_2$ decomposes. The nitrates formed from the impurities are stable at this temperature and are removed from the final product by extraction with water. (1,293,461; Feb. 4, 1919.)

ALFRED A. WELLS of Montclair, N. J., prepares a carbide of manganese by heating pyrolusite and coke together in an electric furnace. The iron carbon formed simultaneously is not readily decomposed by water, while the Mn_3C is converted into a flocculent hydrate $(MnO_2H_2)_2$, which may be separated from the heavier undecomposed carbides by floating. Upon oxidizing the hydrate in aqueous suspension by ozone, or a mixture of air and ozone, a very efficient variety of manganese dioxide results, which is considered to be either a polymerized form, or a cyclic modification.

$$3MnO_2 + 7C = Mn_3C + 6CO$$
$$Mn_3C + 6H_2O = (MnO_2H_2)_2 + CH_4 + H_2$$
$$2(MnO_2H_2)_2 + 3O_2 = 2Mn_3O_8 + 6H_2O$$

(1,293, 272; Feb. 4, 1919; assigned, by mesne assignments, to National Carbon Co.)

By-Products From Iron Blast-Furnaces.—H. B. WEAVER and JAMES GAYLEY of New York note that volatile potassium cyanide and carbonate, together with a much smaller amount of sodium compounds, may be withdrawn from the bosh of an iron blast-furnace through suitable openings near the tuyere zone and condensed in quantities sufficient to make the process commercially feasible. The patentees think that these compounds are formed at the focus, and exist unchanged for a certain distance up the bosh in the hot reducing atmosphere, but there break up, and the basic portion is largely condensed and returned. In this manner, a zone of high-alkali volatiles exists, being continually renewed by the descending charge, and bled mostly by the formation of slag. It can, however, be abstracted either continuously or intermittently as noted, care being taken to withdraw a quantity of gas which carries less heat than the normal excess of hearth over shaft heat. This is controlled by frequent test slag-taps—dark slag immediately indicates improper working and slagging of iron due to excessive withdrawals of heated gas. (1,292,937; Jan. 28, 1919.)

Concentrating System.—RUDOLF GAHL of Denver, Colo., notes that in either water or flotation concentration the middling product is difficult to handle owing partly to the accumulation of altered or partly decomposed minerals. At other times tailings (particularly from flotation machines) contain considerable amounts of unrecoverable oxidized minerals. He therefore patents the process of producing a clean concentrate, then roasting the deslimed middling and leaching it by suitable reagents either alone or in conjunction with the tailings, and finally recovering valuable metals in solution by electrodeposition or otherwise. (1,291,824, Jan. 21, 1919.)

Synopsis of Recent Chemical and Metallurgical Literature

Metallurgical Practice.—H. L. CAMPBELL, metallurgist of the Industrial Works, Bay City, Mich., which specializes on locomotive cranes, has given a paper before the Steel Treating Research Society, which is published in their *Proceedings*. In it he presents the accompanying tabulation of physical and chemical properties specified for various crane parts, together with the directions for heat treatment.

TABLE I. PHYSICAL SPECIFICATIONS OF METALS

Material	Heat Treatment	Tensile Strength	Elastic Limit	Elongation per Cent.	Reduction, per Cent.	Scleroscope No.
Hammered steel, C 0.30 to 0.40 per cent	...	65,000	30,000	36	52	22
Hammered steel, C 0.30 to 0.40 per cent	R.	90,000	60,000	25	50	30
Hammered steel, C 0.20 to 0.30 per cent	...	63,000	30,000	35	50	20
Hammered steel, C 0.20 to 0.30 per cent	R.	80,000	45,000	30	50	27
Hammered steel forged, C 0.20 to 0.35 per cent	R.	101,000	62,500	21	34	33
Hot rolled steel shafting, C 0.25 to 0.35 per cent	...	60,000	26,000	40	50	19
Hot rolled steel shafting, C 0.25 to 0.35 per cent	R.	65,000	35,000	35	55	22
Hot rolled steel rectangular bars, C 0.25 to 0.35 per cent	...	50,000	30,000	40	70	15
Hammered steel (forged as keys), C 0.20 to 0.30 per cent	...	100,000	90,000	20	38	46
Trojan steel, C 0.40, Cr 1.00, Ni 2.00	...	120,000	95,000	18	50	30
Swedish iron	...	50,000	30,000	30	40	16
Wrought bar iron	...	50,000	26,000	32	35	17
Cold rolled steel (shafting)	...	82,000	73,000	20	45	28
Cold rolled steel (studs and bolts)	...	85,000	75,000	18	35	30
Cold rolled steel (keys)	...	80,000	70,000	22	50	27
Machine bolts (large size blank bolts)	...	65,000	35,000	30	40	20
Cast brass B21	...	20,000	16,000	5	5	12–14
Cast brass B21 compression	...	115,000	19,000			
Cast brass B27	...	25,000	18,000	10	10	14–16
Rolled brass (in stock)	...	56,700	47,000	30	45	36
Parsons' manganese bronze	...	65,000	30,000	25	25	.....
Cast vanadium steel (general castings other than beams)	P.	100,000	70,000	20	32	32
Cast vanadium steel (beams)	J.	100,000	65,000	20	35	32
Cast carbon steel	...	60,000	30,000	25	30	20
Cast carbon steel	E.	70,000	40,000	30	40	19
Cast carbon steel	F.	61,000	37,000	32	45	17
Cast carbon steel (gears)	K.	85,000	50,000	25	40	21
Cast carbon steel (gears with hard wearing surfaces)	R.	95,000	60,000	22	30	24
Cast carbon steel (rollers with very hard surfaces)	L.	100,000	70,000	15	25	30
Structural steel	...	60,000	38,000	28	54	24
Special brake band steel	...	95,000	60,000	12	20	35
Soft brake band steel	...	50,000	35,000	40	50	22
Stay bolt iron	...	49,000 53,000	24,500 26,500	30	48	.....
Gray cast iron	3,200 Pounds, transverse breaking load on 1½-in. bar with 12 in. between supports.					
Gray cast iron	20,000 Pounds, tensile strength per sq.in.					
Gray cast iron	100,000 Pounds, compressive strength per sq.in.					
12 per cent semi-steel	3,000 Pounds, transverse breaking load on 1-in. square bar with 12 in. between supports.					
12 per cent semi-steel	20,000 Pounds, tensile strength per sq. in.					
30 per cent semi-steel	3,500 Pounds, transverse breaking load on 1-in. square bar with 12 in. between supports.					
30 per cent semi-steel	30,000 Pounds, tensile strength per sq.in.					

TABLE II. CHEMICAL SPECIFICATIONS

	C	Si	Mn	S	P
Cast vanadium steel	0.30	0.27	0.80	<0.03	<0.05
Cast carbon steel	0.24 to 0.32	0.25 to 0.30	0.65 to 0.80	<0.08	<0.06
Gray cast iron	.....	1.6 to 1.9	0.5 to 0.9	0.06 to 0.08	<0.50
12 per cent semi-steel	.....	1.8 to 2.25	0.95 to 1.0	0.04 to 0.06	<0.50
30 per cent semi-steel	.....	1.4 to 1.5	0.95 to 1.0	<0.05	<0.30

Heat treatments are as follows:

E. Heat to 1600 deg. F. and hold for 30 min.; cool in air for 10 min.; replace and cool in furnace, leaving door open until temperature is below 1300 deg. F. For mud rings, and door rings.

F. Heat to 1600 deg. F. and hold for 60 min.; cool in air to below red heat; reheat to 1250 deg. F. and hold for 90 min.; cool in furnace. For large castings to produce maximum softness with fine grain.

J. First heat: Heat to 1800 deg. F. and hold for 2 hr.; cool in air. Roughing cuts. Second heat: Heat to 1200 deg F. and hold for 3 hr., cool in furnace. Finish machining. For vanadium steel jack-beams.

P. Heat to 1800 deg. F. and hold for 60 min., cool in air to below red heat; reheat to 950 deg. F. and hold for 90 min., cool in furnace. For vanadium steel castings.

L. Heat to 1600 deg. F. and hold for 60 min.; quench in water and remove while warm; reheat to 750 deg. F. and hold for 90 min., cool in furnace. For roller pins and parts of maximum hardness.

K. Heat to 1600 deg. F. and hold for 60 min.; quench in oil and remove while warm; reheat to 900 deg. F. and hold for 90 min., cool in furnace. For gearing.

R. Heat to 1600 deg. F. and hold for 60 min., quench in water and remove while warm; reheat to 900 deg. F. and hold for 90 min., cool in furnace. For hammered or rolled shafting and castings.

This company makes its own alloy steel by addition to converter metal. Sixteen pounds of 35 per cent ferrovanadium and 18 lb. 80 per cent ferromanganese per ton of steel are preheated in the ladles; 10 lb. 50 per cent ferrosilicon is added during pouring from converter.

Rupture of Cast Iron in Contact With Mixed Acid.—In a paper read before the Edinburgh section of the Society of Chemical Industry, A. C. CUMMINGS of the Lothian Chemical Co., Ltd., called attention to the possible dangers arising from the use of cast-iron apparatus with nitric or fuming sulphuric acid. (*Journal* Soc. Chem. Ind., Feb. 15, 1919, p. 31T). In connection with the manufacture of TNT, this company used cast-iron acid eggs for handling the mixed acid, which consisted of 50 per cent nitric acid, 45 per cent of sulphuric acid and 5 per cent of water. About two years ago, two of these eggs burst while blowing was in progress, with serious results. The dimensions of the eggs were as follows, those of the second egg being in parentheses: Internal diameter, 4 ft. (6 ft.); depth, 4 ft. 9 in. (6 ft.); average thickness of walls, 1 in. (1½ in.). The air pressure was normally much lower than the maximum of 60 lb. per sq.in. In bursting, the egg appeared to fall in rather than to be blown out.

Examination of pieces of the iron showed that corrosion was practically negligible. Furthermore, the tensile strength of the iron from the inner surface was still equal to that of the original iron, consequently the egg should have been able to resist a pressure many times greater than that actually employed. However, on breaking a washed piece of the iron, the odor of acid was noticeable, and after two days the inner half of the fracture was badly rusted. Photomicrographs showed graphitic plates of large size which formed "nests" near the surface of the iron, making a coarse or open structure. As a result, acid had actually penetrated to a depth of about one-third of the thickness and in many places small masses of crystallized iron salts could be seen in the interior.

The action of fuming sulphuric acid on cast iron was observed by R. KNIETSCH (Ber., 1901, 34, 4090), who gives the following explanation:

"This remarkable phenomenon is caused by oleum diffusing into the pores of the cast iron, and there be-

ginning its work of destruction, inasmuch as it is converted into sulphur dioxide and hydrogen sulphide by the reducing action of the iron, and may even give rise to carbon dioxide from the carbon in the iron. All of these substances are gases with comparatively low critical temperature, and consequently cause high pressure in the interior of the cast iron. If such a piece of iron is broken, the presence of sulphur dioxide and hydrogen sulphide may be recognized by the smell and the evolution of gas when it is immersed in a suitable fluid."

MR. CUMMINGS' theory is that the disruption is due to the expansive force of the crystals of iron salts growing in the interior of the metal. Examination of some cast-iron measuring pots which had been used for mixed acids, but had never been under pressure, showed the presence of cracks of a similar nature. This would tend to substantiate the crystallization theory.

Regardless of theory, the fact remains that the penetration of the acid into the surface of the casting is the initial factor in the disruption of the apparatus. It would thus appear that the aim of manufacturers of cast-iron apparatus for use with nitric or fuming sulphuric acid should be to avoid as far as possible an open structure which would permit the acid to penetrate into the interior of the iron.

Purifying Paraffine Wax.—In the *Engineer*, Feb. 14, 1919, a description is given of a process devised by R. S. DICKIE, which is an improvement on the sweating process for refining paraffine. It is applicable to hard, middle or soft scale, or a mixture of all three. The material to be treated is melted at as low a temperature as possible and is then pumped through a spraying nozzle, in which a blast of cold air atomizes and at the same time chills the scale. The temperature of the material issuing from the nozzle is 5 to 10 deg. F. below the melting point of the scale. At this temperature, the particles of wax solidify, while the oil and low melting point paraffines remain liquid. The atomized mass passes into a rapidly revolving drum formed of fine mesh wire cloth. The liquid portion of the mass is separated from the yellow wax by centrifugal force, and is collected in an annular trough surrounding the drum. From one to three minutes suffices for the separation of the heavy oil. The residue of yellow wax is removed by heating the drum electrically to 140 deg. F., the melted wax being collected in a second annular trough.

Specific Heats of Silicates and Platinum.—WALTER P. WHITE of the Geophysical Laboratory has published a second series of specific heats of silicates in the *American Journal of Science*, 47, 1 (1919), and also a determination of the specific heat of platinum at high temperatures, using the same apparatus, in the *Physical Review*, 12, 436 (1918). The results for platinum up to 1300 deg. C. are thought to be accurate to within 3 per mille, and the increase of the specific heat at constant pressure with rise in temperature is so nearly linear that the following equations hold:

True specific heat $= 0.031686 + 0.000064$ deg. C.

Atomic heat, $A_p = 6.185 + 0.00125$ deg. C.

There is no reason to suppose that this specific heat at constant pressure really varies linearly, since the work of expansion does not; yet it gives a simple expression well within the accuracy of the experimental data. The specific heat at constant volume cannot be determined experimentally, but may be calculated from the values for constant pressure. The figures for several temperatures are as follows:

Deg.	A_v
500	6.447
900	6.678
1300	6.844

It will be noticed that A_v increases regularly with advancing temperature and, also, that it is above the value 5.96 indicated by the accepted kinetic theories of the solid state and Delong and Petit's law (as modified by G. N. Lewis *et al.*).

Micrometer With Pressure Attachment

A CONVENIENT instrument for testing the properties of rubber, felts, etc., used for packing, gaskets and various compressibles has recently been put on the market by S. W. Widney of Chicago.

The resiliometer is, in effect, the combination of a direct reading dial type micrometer gage with a reaction device whereby both the compressibility and the rebound after compression (otherwise known as the resilience) of the material can be determined positively. The readings are simple, and therefore easily understood.

The resiliometer gives the following information in direct readings:

Thickness (normal), in thousandths of an inch (first standardized method).

Hardness, i.e., the precise extent to which a material gives as the result of a standard pressure (first standardized method).

Resilience, i.e., the rebound—the capacity to recover from compression after the load is released. Resilience is a quality not fully understood by many large users of felt, rubber, leather, paper, cork, textiles and other compressible materials, as not infrequently the resilience is estimated in excess of the load applied. This is impossible because compression, while it may destroy energy, cannot create it. Therefore, the maximum resilience is the amount of the load.

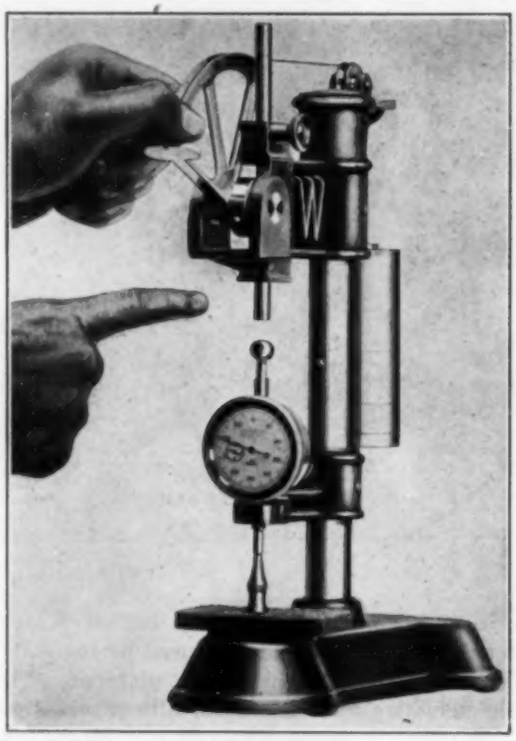
As will be seen by a glance at the illustration, the instrument consists primarily of a dial underneath which is a presser-foot touching a perfectly level base on which the material is supported. Making sure that the quadrant which holds the weight descending from it is drawn up and held by the spring-catch, the operator lifts up the presser-foot and inserts the material which is to be gaged and tested.

The large dial is graduated in 100 divisions of 1/1000 in., so that one revolution of the large pointer or hand is equivalent to an elevation of 0.1 in. To count tenth-inch increments a small dial indicates the number of revolutions of the counter or hand. Suppose the material to be tested is 0.100 in. thick, then as the presser-foot goes down, the hand stops at the 100th gradation.

Release the spring-catch holding the weight and allow the weight quadrant to swing back until pressure is put on upper end of presser-foot at the top of dial. As weight is released, the plunger, which is connected with the quadrant, forces the presser-foot to sink into the material, thereby diminishing its thickness. When the presser-foot reaches the limit of compression with the weight applied, the reading on the dial at that time is taken and compared with the normal or original reading. For instance:

Normal thickness reading.....	0.100 in.
Reading under pressure.....	0.050 in.

These readings are interpreted that goods of a normal thickness of 0.100 in, showing under pressure a thickness of 0.050 in., are 50/100 hard. The material is arbitrarily called 50 per cent hard. If it had not been compressed at all its hardness would have been 100 per cent (an impossibility with any resilient material). If it had compressed to one-fourth its original thickness, its hardness would have been 25 per cent. If it had compressed to one-tenth of its original thickness, it would



MICROMETER WITH PRESSURE ATTACHMENT

have been 10 per cent hard, and so on. This gives us the hardness figure of the material in question—a figure henceforth fixed in comformity with the Widney standard.

As soon as the reading has been taken, pull the quadrant back, releasing weight pressure on the presser-foot. The hand on the dial will begin to advance again. When weight is raised a sufficient height so that the weight pressure is released from the presser-foot, immediately note the reading of the dial hand. This reading should be taken as weight pressure is released, thereby ascertaining the instant comeback or rebound and not the gradual return.

For example if the dial-hand (which was at 50 under pressure) advances as pressure is released till it reached 0.080 in., the rebound is 60 per cent. For 80 — 50 = 30 and 30 is $\frac{3}{5}$ of 50 = 60 per cent. Had the material tested immediately resumed its original thickness, the rebound would then be 100 per cent. The ratio of the distance of rebound to the distance of compression is the percentage of rebound.

The capacity of a material to rebound after the load is released is often confused with the resilience. However, a distant rebound is not the true measure of resilience. Bear in mind that resilience is the capacity which the material has for giving back energy given it during the loading process. The only existing means of ascertaining the amount of this energy is by the resiliometer method—applying successive increments of load, plotting the increment line, and removing the load in successive decrements, plotting the decrement line. Between these two lines is the hysteresis or energy load. The area back of the line indicates the amount of energy recovered after the load is released.

Resilience also is sometimes confused with elasticity, which is the capacity of material to distend or reflect, as illustrated by the action of a rubber band after being stretched beyond its normal position or the reaction of a steel bar after being bent out of its original or normal position.

Logically, the resilience of any compressible material is determined by its capacity to recover from compression after the load is removed.

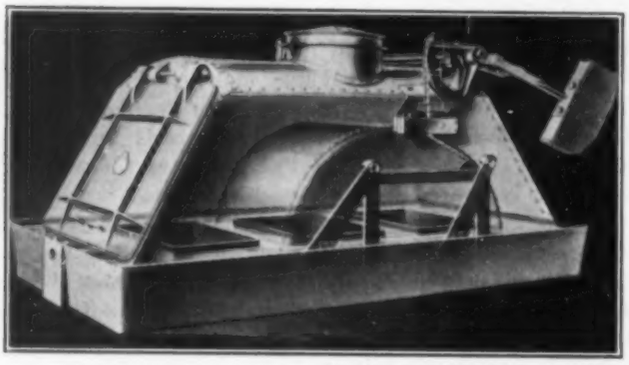
Gas Reversing Valve

IN THE operation of any gas-fired furnace, it is highly desirable that the valve controlling the direction of the flow of gas shall operate rapidly and easily. These factors have been kept in mind in designing the new W-S-M gas reversing valve which has just been placed upon the market by the Wellman-Seaver-Morgan Co. of Cleveland, Ohio. That the conditions have been met is evidenced by the fact that a 36-in. hand-operated valve can be reversed in from 3 to 7½ sec. with a pressure of not more than 25 lb. This is accomplished by a balanced hood and counterweights. An equally important feature is that the operating mechanism is outside of the casing, where it is easily accessible and always cool.

The center port is connected to the chimney. Waste gases from the furnace flow from whichever outside port the hood is covering to the chimney port. This leaves a clear passage for the fuel gas or the air entering the casing through the mushroom valve at the top to pass through the third port to the furnace regenerator. Reversal of the flow of gas or air is accomplished by moving the hood to a position over the center port and the one previously uncovered.

The base of the valve is a cast iron rectangular pan with three walled circular openings or ports. The hood which covers the center and one end port is semi-elliptic in form and made of steel plates with angles at the bottom to support a fire-brick lining. The base pan holds a quantity of water so that when the hood is over the ports a water seal is formed to prevent the escape of gas. The base pan has a tapped hole at each end for a water pipe. There is a perforated strainer at the intake end and a dam plate at the other end to hold the water at such level as to allow the hood to extend 3 in. into the water forming the seal.

The outer casing is made of steel plate and lined with fire brick. It has cast iron door frames and door at each end through which the hood may be removed or inserted. Each door has a small peekhole with a swinging cover which enables inspection at any time. On the top of the casing is a cast iron neck which connects either with the fuel gas flue or the air intake, depending upon the purpose for which the valve is used. The hood is moved by a series of levers and coupling shafts which extend through the water under the casing and into sockets on the hood. The shafts move on chilled iron bearings. The following advantages are claimed for this valve:



NEW DESIGN OF A GAS REVERSING VALVE

The semi-elliptical form of the hood allows free flow of the gas, as there are no abrupt turns or constricted areas in the passage formed by the ports and hood. This feature is very important in obtaining maximum efficiency from the stack draft.

All leakage or waste of gas is prevented by the water seal. Such a seal does away with all packing, tightening and adjusting, the only attention required being the flow of a small quantity of water into the bed plate to replace the amount evaporated.

Due to its compactness, the valve requires comparatively little floor space and adapts itself to various arrangements of flues from the regenerators to the stack.

The weight of the hood is counterbalanced by the weights of the lever arm in such a way that the hood is in balance at any position, so to move the hood it is only necessary to exert enough force to overcome friction. This is an important feature in hand-operated valves.

New Type of Portable Arc Welder

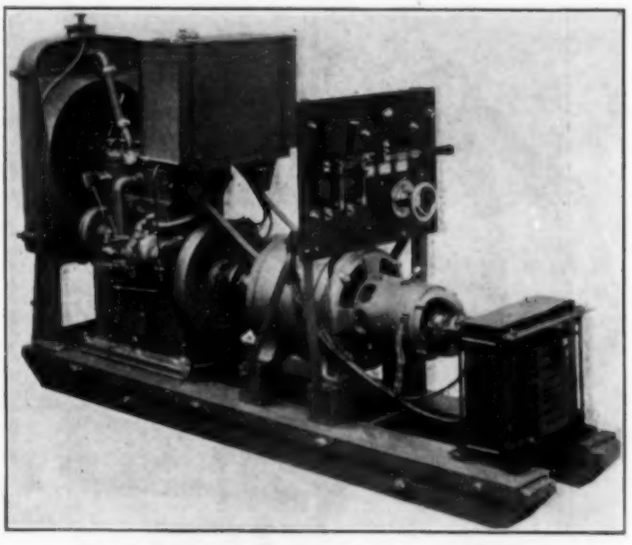
ALTHOUGH electric arc welding has been used for several years in the iron and steel industry, its use has mostly been confined to factories, repair shops and other locations where the work can be brought to the machine. The accompanying illustration, however, shows a new type of portable arc welder, which presents especially interesting features and is designed for operation where electric current is not available.

It consists of a Lincoln Electric Co. 150-amp. arc welding generator direct connected to a Winton G. L. 5-gasoline engine, and is intended for mounting on an automobile truck or other convenient position so that it may be transferred from place to place. An interesting point in its construction is the method adopted to insure a steady arc and a constant and readily controllable heat—the two greatest difficulties met with in the design of this class of apparatus.

The volts required to maintain a welding arc vary from 50 down to as low as 15 volts (where a metal electrode is used). The plan adopted by most makers to render the arc steady is to introduce sufficient "ballast resistance" in series with the arc to prevent excessive current being taken when the operator short-circuits the generator on "striking the arc." This method is exceedingly wasteful, more than three-quarters of the power generated being absorbed in the ballast resistance itself.

This arc welder uses a compound-wound generator, the series windings of which are connected up so as to oppose the shunt field, and the two windings are so proportioned that the voltage decreases in the same ratio as the current increases, thus limiting the short circuit current. Another important effect of this is that the horsepower, and therefore the heat, developed for a given setting of the regulator switch (shown on the control board above the generator) remains practically constant.

It is asserted that a kilowatt-hour can be made to do four or five times as much work with this



PORTABLE ELECTRIC ARC WELDER

welder than with machines using ballast resistance. Additional arc stability is also insured by the stabilizer (seen at the extreme right of the picture). This is a highly inductive low resistance coil connected in the welding circuit. It serves to correct momentary fluctuations of current in much the same manner as the flywheel of an engine produces an even turning speed.

Pyrometer for Brass and Bronze

THE importance of the pouring temperatures in the manufacture of brass and bronze castings is so well recognized that comment on that fact is hardly necessary. Wrong temperatures are probably the chief cause of faulty castings. This factor not only enters into the production of the casting itself, but the properties of the finished article are also affected.

The chief difficulty of measuring the temperature by use of the ordinary thermo-electric pyrometer has been the lack of a suitable protection tube for the thermocouple. There is a limit to the thickness of the tube wall which is permissible because of the necessity of a quick reading. The tube has to be of relatively thin walls, but at the same time it must successfully withstand the action of the molten material. Refractory tubes are not satisfactory because they are too fragile to stand ordinary foundry use, and are very apt to break under the sudden temperature changes encountered.

An alloy has been developed, however, by the Hoskins Manufacturing Co., Detroit, Mich., from which a satisfactory protection tube can be made. Fig. 1 illustrates how the equipment is used. The tube consists of three parts, as shown in Fig. 2. Section *B* telescopes into the upper end of the seamless steel tube *D*, and the

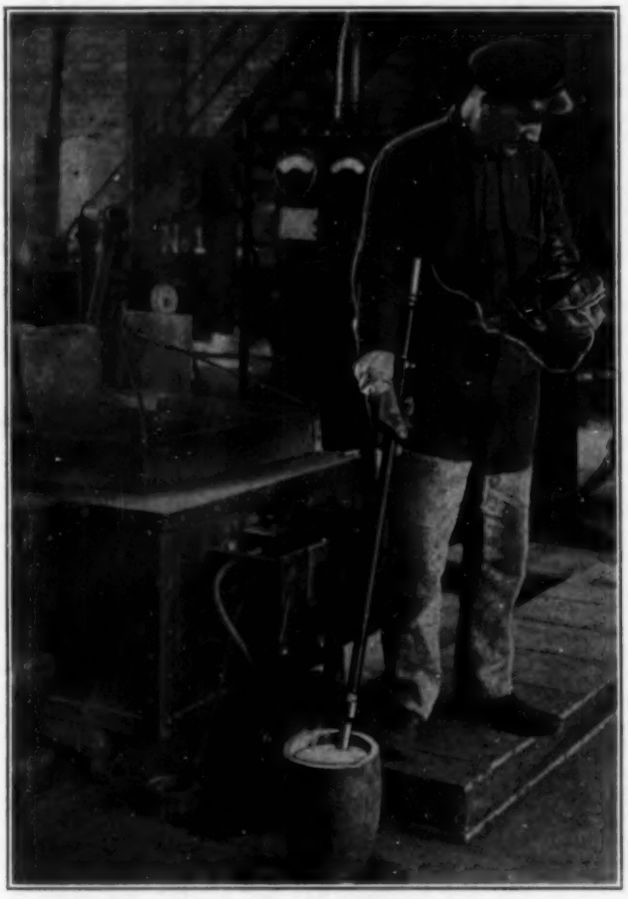


FIG. 1. READING THE PYROMETER

protection tube proper, marked *C*, is held in the lower end. This tube is 10 in. long and is made of the new alloy chromon; it is that part of the entire tube which is inserted into the metal. The thermocouple *A* is entirely encased in the tube and can be easily renewed.

The alloy tip and the thermocouple are the only parts which require renewal. When the molten metal ultimately destroys the alloy tube, it can readily be removed and a new one installed. A shoulder is cast on the upper end of the tip and this engages in the collar shown on the tube *D*, being held in place by giving it a half turn and packing the connection with a special refractory cement.

If the tube is used to complete destruction or to a point where the molten metal can reach the thermocouple, of course the latter has to be repaired. This can be done by merely cutting off the damaged part, and then twist and re-weld the wires. This procedure can be repeated until the couple reaches a length of 3½ ft., when it must be renewed. The couple can be changed end for end; that is, the unwelded end can be welded and used as the hot end. It is not necessary to re-calibrate the couple after re-welding it.

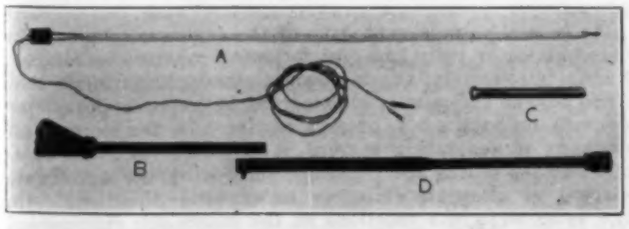


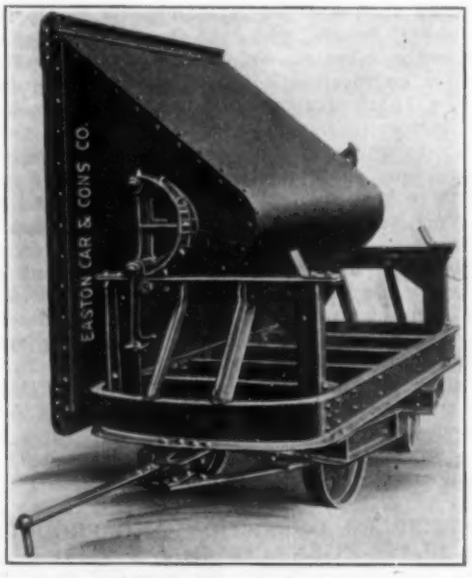
FIG. 2. PYROMETER FOR BRASS AND BRONZE

Trackless Trailer With Dump Car Body

THE increasing use of industrial tractors has created an unusual demand for all kinds of trailers. To meet the demand for a car that would not only admit of easy trailing but would also speed up loading and unloading of loose materials the new Easton car here shown was developed.

It is a four-wheel steer trailer that will run over cement, wood, composition or any kind of flooring. In fact, it will even run quite smoothly over rough ground when supplied with extra large wheels. All wheels are equipped with roller bearings and may be furnished with rubber or composition tires. Close tracking of trains of these cars is accomplished with comparative ease because both front and rear trucks of each trailer swivel. Trains of six cars will track within three inches and will take a curve of 8-ft. radius or smaller.

The body of the trailer is distinctive and possesses many features that make for economy and speed in loading and unloading coal, ashes, sand, ore, slag,



TRACKLESS TRAILER WITH DUMP CAR BODY

refuse and practically every kind of bulk material. Some of the more important features include: Special latch for locking the body in a half-dumped position, thus lowering the loading height for hand loading; automatic safety latches; extra heavy body that dumps clear of the wheels, the only type that will so dump (45 deg. angle of dump); cast-steel rockers and extra heavy underframes.

The car is built by the Easton Car & Construction Co. of Easton, Pa.

Italian Import Restrictions

The following commodities may now be imported into Italy by private importers when import licenses have been obtained covering such shipments. Formerly these commodities were among those which private importers might not import into Italy: Acetate of lime; acetone; alcohol; benzol; toluol; naphthaline; vegetable and animal tallow; leather; jute; wool, and cotton linters.

Book Reviews

A HANDBOOK OF PHYSICAL MEASUREMENTS. By *Ervin S. Ferry*. Two volumes. Price $2.00 each; 234 pages, including the index; illus. New York: John Wiley & Sons, Inc.

The author of this work has followed the plan of presenting at length the theory of the experiments and the derivation of the formulæ required in each division of the subject before giving descriptions of apparatus to be used and directions for the actual manipulations necessary in performing the experiments. The exposition of the theory is as brief and concise as is consistent with the author's purpose as indicated by his statement, "It is rare that an experiment should be performed before the student understands the theory involved and the derivation of the desired formulæ."

The first volume contains three chapters, the first being an introductory chapter upon physical measurements in general. Chapter 2, after a discussion of the theory and methods of fundamental measurements, gives detailed directions for 25 experiments upon the properties of matter. Most of these are standard in college laboratories, although several are somewhat novel, notably the last two, for determining liquid viscosity. The third chapter, occupying over half of the first volume, gives the theory and directions for 25 experiments in optics. Of these, several are unusual in a college or engineering course, particularly those which employ the spectrograph, spectrophotometer, colorimeter and polarimeter.

Vol. II contains four chapters, the first including 4 experiments upon vibratory motion, the second 10 in sound, the third 20 in heat, the fourth 24 in electricity and magnetism. Among these experiments are several usually performed in courses more advanced than those in general physics as given in most colleges or engineering schools. The author, while he states that some of these would be performed only by students specializing in physics, evidently believes that these more difficult experiments rightfully belong among those performed by the student during the time occupied by him in laying foundation for later more technical scientific knowledge. With this in view, the writer of this review fully agrees.

On the whole this manual is on a considerably higher plane than most of its kind.

THE PRINCIPLES, OPERATION AND PRODUCTS OF THE BLAST-FURNACE. By *J. E. Johnson, Jr.* 552 pages, illus.; price $5.00. McGraw-Hill Book Co., Inc.

This is the companion volume to the same author's "Blast-Furnace Construction in America." Together the two volumes form the most comprehensive treatise in any language on the subject of the iron blast-furnace, upon which J. E. Johnson, Jr., by virtue of his education and long practical experience, was an established authority. In the first six chapters of the book are discussed the chemical, thermal and mechanical principles in a manner which has the rare combination of being both exhaustive and clear. Of the chemical principles, Sir Lowthian Bell will long be remembered as the original and greatest expounder, while Johnson was likewise recognized as the exponent of the now generally accepted thermal theory, involving a critical temperature and available heat in excess of that temperature—a theory which had to win its way to a position of authority against the conservatism of many a learned professor, especially of the German school.

More than one-half of the book is devoted to the application of these several principles under the head of "Operation," in which place are treated the ascending column of gases and descending column of solid materials, slag, burdening, rate of driving, handling the furnace, irregularities and their treatment, and the combustion of gas. One notices a weakness in the lack of specific directions as to the application of some of the principles; for example, in no place do we find instructions as to the difference in practice when making foundry pig iron, ferromanganese and ferrosilicon. Truly the general principles are laid down with force and clarity, so that any capable and intelligent man can apply them and obtain the answer for himself, but for students and those who prefer to have others do their thinking for them, the classified repetition would be welcome.

Under the head of "Products" the author gives a good, scientific, although brief, account of the various commercial forms of pig iron, the effect of different elements, and the principles governing these effects. It will be remembered that Johnson was the first to publish (*American Machinist*, April 5, 1900, page 317) the theory of steel and cast iron as a continuous series of alloys of iron and carbon. The argument and the information given to practical foundrymen in this book are good; the micrographs are excellent and bring out well the points they illustrate.

The book closes with a valuable, thoughtful section on "Commercial Considerations and the Future Possibilities." There is an index, which is too perfunctory in character and limited in scope.

EXPLAINING THE BRITISHERS. By *Frederic William Wile*. Price $0.85, 118 pages, illus. Published Autumn, 1918. London: William Heinemann.

One of the most important things accomplished by the war was the establishment of more intimate and friendly relations among individuals of the allied nations. The American, for example, discovered the Britisher, and found, possibly to his surprise and certainly to his pleasure, that the latter was quite as natural and interesting a human being as his descendants in America. The book under consideration was written by an American for the purpose of explaining to the members of the American Expeditionary Forces some of the little peculiarities of our British friends. It was also designed to give the American and any one else who will read it a clearer idea of Great Britain's contribution to the war, dispelling the crude notion that England was not playing the game to the limit. Although written before the armistice was declared and primarily to predispose American troops favorably toward their brothers in arms, the book will have a permanent value in creating the proper spirit among members of the English-speaking races. It is written in the agreeable style of a versatile newspaper writer and presents facts and figures in an easy manner. It can be read with pleasure by every good American and with profit by any one who has been inclined to give ear to anti-British propaganda.

THE APPLICATIONS OF ELECTROLYSIS IN CHEMICAL INDUSTRY. By *A. J. Hale*. ix + 148 pages, illus. Cloth. Price $2.50 net. New York: Longmans Green & Co., 1918.

This book is one of the Monographs on Industrial Chemistry edited by Sir Edward Thorpe. It consists of an introduction and eight chapters. The introduction gives an account of the general principles of electrolysis and an explanation of electrochemical terms. The chapters have the following headings: Methods of Generating the Current; The Electrolytic Refining of Metals; The Electrolytic Winning of Metals; Electrolytic Production of Hydrogen and Oxygen; Chlorine and Caustic Soda; Hypochlorites, Chlorates, Perchlorates; Production of Inorganic Compounds.

This work is principally a description of the important electrochemical industries, is very readable and is on the whole a good introduction to the subject. The paper and print are excellent and the book has a pleasing appearance.

As it is the unpleasant duty of the reviewer to point out inaccuracies or omissions, the following must be mentioned. In the introduction, the inaccurate statement is made that when copper sulphate is electrolyzed between copper plates there is no back e.m.f. of polarization. In the chapter on methods of generating current, it is stated that lead storage battery plates are generally formed by the old Planté method of alternate charging in opposite directions. On the same page, the reactions at the plates are represented as occurring in two steps, involving loss of free energy cor-

responding to the reaction $PhO + H_2SO_4 = PhSO_3 + H_2O$, which loss does not occur. In the refining of metals, the explanation of why anode impurities behave differently is not given, and in describing the series system, it does not explain how the pure copper is separated from the undissolved impure copper. Other similar points might be mentioned. In the chapter on the winning of metals, nothing is said of the important process for producing copper used at Chuquicamata, Chile, and of similar work in the United States. Finally, the Darling process is incorrectly stated to be regarded favorably in America, while it has never been a success.

TREATISE ON APPLIED ANALYTICAL CHEMISTRY. By *Prof. Vittorio Villavecchia*, Director of the Chemical Laboratories of the Italian Customs, translated by *Thomas H. Pope*, B. Sc., A. C. G. I., F. I. C., University of Birmingham. 1918. Vol. II. Price $6.00. 536 pages, 105 illus. Philadelphia: P. Blackiston's Son & Co.

The first volume of this work was reviewed in our Vol. xviii, p. 488. This, the second volume, contains a good treatise on analytical chemistry applied to foodstuffs such as meat, milk, flour and beverages, and to some additional industrial products such as essential oils, varnishes, inks, leather and coloring matters. In wine and spirits we shall have at least an academic interest hereafter, and we will find much information here. Essential oils are well treated. Rubber, which was noticed by the reviewer as being absent from the first volume, is fairly well discussed.

It is curious to observe how the author's tastes or experiences are indicated by the relative amount of text under each head. Milk and its products occupy 22 pages; flour and derived products, 30 pages; sugar, 77 pages; varnishes, 7 pages; inks, 5 pages; leather, 9 pages.

Among industrial or food substances which might have been treated but are not found in these volumes are glass, clays for ceramic and refractory materials, paper and cardboard, explosives. The discussion of textile fibers as well as fabrics, of tests of their waterproofing, quality of methods for determining the weighting of silk, degumming, etc., as well as identification tables for coloring matters, make a particularly thorough chapter. Each one of these reviews of analytical methods is closed by a critical digest of the subject with emphasis upon the best criteria to rely upon. This is a good feature.

The cuts on prepared paper are good; the remaining cuts in many cases crude in drawing and poorly printed.

GAS AND FLAME IN MODERN WARFARE. By *Major S. J. M. Auld*, Royal Berkshire Regiment. Price $1.35. New York: Geo. H. Doran Co.

Shortly after the United States entered the war there was a great commotion about gas, and yet nobody seemed to know much about it. At least, only a few persons did. Of the vast majority, some knew a little, and were as secret as comic opera conspirators about it; others knew more—that is, they knew parts of more, but not the whole of anything. There was, however, one person among the few who was abundantly informed, who had had large experience, and who had a clear notion of what might be told and what might not. He was a strenuous worker in getting production started, a man of amazing ubiquity, approachable, affable, and keen as a whistle. It is not surprising, therefore, that when inquiries were made about this new method of warfare, the usual answer was, "See Major Auld if you can; he knows all about it." It is not of record that he ever overstepped the mark, or gave out information that would be of value to the enemy.

The gentleman was Major, now Colonel, S. J. M. Auld, sent here by the British at the request of the U. S. Government to aid us in those preparations for gas warfare which finally helped to take the heart out of Fritz and to impress upon no less a person than the great Von Ludendorff himself that there was something wrong about that last German "victory" drive. Colonel Auld is a chemist of parts; he wears the Military Cross for crawling into enemy trenches to observe the effect of a British gas attack, and he has been wounded in battle. A good soldier, and, as we should say, a live wire. He was in the trenches opposite Messines in April, 1915, when the Germans launched their first gas attack, and he was in the thick of the business from that time until the end of the war. His book, "Gas and Flame," tells the story very much as one would expect him to talk to a favored group of men sitting about a cosy fire in a pleasant club. It was designed for the general public rather than technical men, nevertheless the facts as to gases and what they are, are duly set forth.

The onus of introducing gas to the German military authorities and persuading them to use it he lays at the door of Professors Nernst and Haber. Nernst was one of the most arrogant pan-Germans and Anglophobes, and was made a Count (Graf) by the Kaiser for his "distinguished services." Long before the war started Haber and his assistants were known to have been working on poisonous arsenical gases and liquids. Haber also directed operations in the field. The first respirators, the helmets, and the joys and sorrows of drilling men to use them, are all described with the art of a good réconteur. And a great deal of incidental information is given for valid reasons. Of course the direction and speed of the wind in cloud attacks were matters of first importance, and "Beaufort's Scale," as it is called, devised long ago by a British Admiral of that name, was occasionally called upon when instruments were lacking. It is worth remembering:

"If smoke moves straight up, the speed of the wind is nil; if smoke slants, the speed is two miles an hour; wind felt on the face indicates five miles an hour; if paper and the like move about, the speed is ten miles; when bushes are seen to sway, it is fifteen; if tree tops sway and wavelets are formed on the water, it is twenty; and if treetops sway and whistle, it is thirty miles an hour."

The book follows the course of the war until it was written—which was before the armistice was signed. The interest never flags, and good stories abound from start to finish. The last chapter on Flammenwerfer shows the limitations of this method of warfare. There isn't much chance for the man that directs the flame, and it is only in surprises at very close quarters that he can accomplish anything with it.

GENERAL LECTURES ON ELECTRICAL ENGINEERING. By *Charles Proteus Steinmetz*. Fifth edition, compiled and edited by J. L. Hayden, 242 pages, illustrated; price $2.50. New York: McGraw-Hill Book Co., Inc.

So many material changes have taken place during the eight years since the earlier editions of these lectures were published that the author has entirely rewritten large parts of the previous editions and has made material changes and additions to some of the other parts.

These eighteen lectures deal with the generation, transmission, control, distribution and utilization of electric energy. They are written in the lucid, logical, easily understood style, with no waste of words, for which this author is so well known and which always assures him a large attendance at his lectures in various cities. After listening to one of these, no matter on what subject, one always feels that he has learned something or has learned to look at problems in a new or more logical and rational way; the well known and brilliant work done by the author also gives one the assurance that what he says is so, and that his conclusions reached in controversial subjects are the results of a logical, impartial and highly intellectual treatment by one who is exceptionally well posted and has had a vast amount of practical experience.

In the present volume the treatment is of this kind; the lectures are written in easily understood style, essentially descriptive and not mathematical or highly technical. No space is wasted in long historical descriptions of the many things which have been abandoned and superseded; indeed, one of the most valuable features of these lectures is that he gives the conclusions which have been reached as to what is considered the best and the standard practice of to-day, as also the reasons which have led to these conclusions. Another valuable feature is the discussion of the relative advantages and disadvantages of different apparatus and methods, which determine the best choice under different conditions.

Unlike the custom in so many books the author does not begin with "Adam and Eve" but assumes a general familiarity with the subject of electrical engineering, but on the other hand the style is such that no expert knowledge of the subjects is necessary to understand his treatment of them; highly mathematical discussions are almost completely absent.

The subjects of this collection of lectures are: General review; general distribution; light and power distribution; load factor and cost of power; long distance transmission; higher harmonies of the generator wave; high frequency oscillations, surges and impulses; generation; hunting of synchronous machines; regulation and control; lightning protection; electric railway; electric railway motor characteristics; alternating-current railway motors; electrochemistry; the incandescent lamp; arc lighting; modern power generation and distribution. The numerous methods of distribution, with the economy of copper conductors and their other advantages and disadvantages, are very clearly explained with simple diagrams. In discussing the cost of power, he adds to the usual two factors of fixed cost and a cost proportional to the power a third one, depending on the reliability of service required, which embraces the reserve. The discussion of the generation of the power, by water, steam engine, steam turbine and gas engine, is logical and instructive. Quite a long lecture is on the alternating-current railway motor. The lecture on electrochemistry is quite brief, dealing only with a few fundamentals, and from the practical standpoint. In the eighteenth lecture he expresses the opinion that at least for a long time to come there is very little probability that any form of internal combustion engine will even approach the efficiency of the steam turbine, which he considers has become and will remain for some time the "next feature"—the universal source of primary power.

His statement that "electricity is the most useless form of energy . . . and finds no industrial use as electrical energy" is one of those statements that startle one at first, until he explains that to be useful it is always converted into some other form of energy, such as light, mechanical energy, chemical energy, heat, etc., it being the connecting link between the original energy and its final useful form. He shows that with regard to energy, electrical transmission becomes what the railway system is with regard to the transmission of materials.

The volume concludes with an abstract of a recent lecture before the Franklin Institute, and a table giving the reactances for overhead lines.

THE FLOTATION PROCESS. By *Herbert A. Megraw*, 6 x 9, 359 pages, illustrated. Second edition, revised and enlarged. New York: McGraw-Hill Book Co.

The second edition of Megraw's book is a commentary upon flotation in more ways than one. It is both a good book and a poor book at the same time, for even after much excellent reading matter has been added it yet remains mainly a compilation. While Mr. Megraw has written an excellent introduction to the study of flotation for use of a technical student or an operator just taking up this process, the second edition will be found as disappointing as the first by the man who has been doing the actual work and has made it a rule to follow flotation literature as it has appeared.

Unfortunately, investigators, superintendents and managers generally can find little time, official encouragement or energy to write upon the subject they understand so well. It seems therefore inevitable that our technical books shall be written by students of an art rather than real practitioners. Even this state of affairs has certain compensation, since the author can generally draw upon the personal experiences and observations of the leaders in that art freely. Thus it is that our modern technical books show such general excellence.

In the main, Mr. Megraw has had to labor without such aid. He has visited many mills, and read extensively upon his subject. His condensations of his readings are excellent, and he has compiled with judgment. He is therefore not to blame for the shortcomings of his book. He had a right to expect that by this time flotation under the virile leadership of American engineers would have thrown off the yoke of Minerals Separation. In certain clauses of its licenses Minerals Separation strictly forbade all publication or dissemination of knowledge in regard to the art of those using its process, and in addition it claimed ownership of any new discoveries in the general art of flotation made while using its process. For years it succeeded in preventing the publication of many articles dealing with froth-flotation in Australia and in England, and as a result the process never advanced as it should until it was introduced into the United States. Here engineers, metallurgists and editors have largely refused to submit to such dictation, and as a result there has been more real advancement in the last four years than ever before. This advancement has been not because of Minerals Separation but in spite of Minerals Separation. Among editors Mr. T. A. Rickard deserves especial praise for the fearless way in which he has exposed all attempts to prevent the dissemination of technical knowledge even upon flotation. Among mining companies the industry owes gratitude to both Miami and Butte & Superior for the costly fight which they have made against the monopoly.

While other patentees have perverted our patent-law system to their advantage by various clauses in their licenses regarding use, sale and prices, the reviewer believes none has heretofore had the effrontery to try to use rights acquired under an "Act to Promote the Progress of the Useful Arts" to the direct, malicious purpose of preventing the spread of knowledge in that art.

Until that time when flotation has thrown off this clutch we must expect all books upon flotation to be mainly compilations of the writing of those fearless practitioners who righteously tell Minerals Separation to go to, and in public spirit give to the industry the benefit of their observations. Mr. Megraw therefore is to be praised for his public-spirited preparation of a second edition of his book.

Personal

PROF. COMFORT A. ADAMS, who is president of the American Institute of Electrical Engineers and was recently elected president of the American Welding Society, has been chosen dean of the faculty of the Harvard School of Engineering at Cambridge, Mass.

PROF. ALAN M. BATEMAN, of the Department of Economic Geology, Yale University, New Haven, Conn., has become editor of the *Journal of Economic Geology*.

MR. GEORGE G. BROWN, formerly chemical engineer with the Aluminum Co. of America, Messena, N. Y., and chemist for the development section, research division, Chemical Warfare Service, at the American University, Washington, D. C., is now chief engineer for the Universal Aniline Dyes & Chemical Co., Milwakee, Wis.

MR. E. C. CHERRINGTON and MR. T. R. COOLEY have been transferred from the Milwaukee office of the Cutler-Hammer Mfg. Co. to the Pittsburgh office in the capacity of office manager and engineering correspondent, respectively.

DR. FREDERIC DANNERTH has accepted an invitation from the Newark Technical School to deliver a course of thirty lectures on corporation chemistry.

MR. J. F. DEAN, formerly chemical engineer for the Southwestern Portland Cement Co., has resigned to become consulting chemical engineer for the Canada Cement Co. of Montreal. Mr. Dean has been especially active on matters connected with potash recovery.

LIEUTENANT-COMMANDER H. J. ELSON, U. S. Naval Reserve, has been released to inactive status and has resumed his position as secretary and treasurer of the Walter A. Zelnicker Supply Co., St. Louis, Mo.

CAPTAIN GEORGE H. HALL, Ordnance Department, Watertown Arsenal, has been discharged and resumed his position as manager of ozonator sales for the Sprague Electric Works of New York.

MR. ARTHUR LACHMAN has resigned his position as vice-president and general manager of the Great Western Electro-Chemical Co. and the California Alkali Co. These connections were established in the interest of war production in needed chemicals but, that necessity no longer existing, Mr. Lachman will devote himself to his own interest with offices in the Holbrook Building, San Francisco.

MR. JOHN A. MACKENZIE, consulting and designing engineer, formerly with E. B. Badger & Sons Co., is now connected with the Oakland Copper & Brass Works, Seventh and Kirkman Streets, Oakland, Calif.

DR. PAUL D. MERICA, formerly of the metallurgical division of the Bureau of Standards, Washington, D. C., is now physical metallurgist in the research department of the International Nickel Co., Bayonne, N. J.

MR. PHILIP N. MOORE, past president of the American Institute of Mining and Metallurgical Engineers, has been appointed by the Secretary of the Interior to serve on the commission to adjust claims growing out of governmental efforts to stimulate production of war minerals. MR. J. F. SHAFROTH and MR. M. D. FOSTER are also on this committee.

CAPTAIN G. A. ROUSH has been discharged as chief of tests, metallurgical branch, inspection division, Ordnance Department, and has returned to his former position as assistant professor of metallurgy, Lehigh University, South Bethlehem, Pa.

MR. F. V. SARGENT has been appointed by the Chicago Pneumatic Tool Co. district manager of sales in the Boston territory, with headquarters at 182 High St., Boston, Mass.

MR. A. J. SELTZER, former chemist for the Bartlesville Zinc Co., Blackwell, Okla., has opened an assay office in Picher, Oklahoma.

MR. H. D. TROUNCE has accepted a position with the explosives division of the Bureau of Mines, with headquarters in Washington, D. C. His address will be Room 1128, the New Interior Building.

MR. A. P. WATT was married on April 2 to Miss Ethel May Morse of Brooklyn, N. Y.

Obituary

MR. H. R. HANCOCK, inventor of the jig and rock-drill that bear his name, died on Jan. 15 at the age of 83. Mr. Hancock was for twenty-two years in charge of the Wallaroo and Moonta copper mines in South Australia, which will now be managed by his eldest son, H. Lipson Hancock.

MR. ALEXANDER COCHRANE, formerly president of the Cochrane Chemical Co. of Everett, Mass., died suddenly at his home at the age of 79. Mr. Cochrane was one of the original directors of the American Bell Telephone Co. and was identified with the development of its service.

MR. EDWARD F. FREUDENTHAL, mine operator and promoter of Pioche, Nev., died on March 24 at the age of 55 years. He was a native of Pioche and had always made his home there, although spending much time in Salt Lake City and in the East. He is survived by his widow, two sons and a brother.

SIR WILLIAM CROOKES, chemist and physicist, died in London April 4, 1919, at the age of 86. He was born in London June 17, 1832, and entered the Royal College of Chemistry at the age of 16. In 1851 he was assistant professor at the same institution. In 1859 he founded the *Chemical News* while in charge of chemical instruction at Science College, Chester. As editor of the *Chemical News* for sixty years Sir William enjoyed the distinction which has come to few if any editors of scientific papers. The discovery of thallium is credited to Sir William, resulting from an examination of the residue left in the manufacture of sulphuric acid. Crookes tubes and their familiar phenomena, known to every student of physics, were also his invention. Sir William was a publisher of many papers and books, among them being "Select Methods in Chemical Analysis," "Manufacture of Beet Root Sugar in England," "Handbook of Dyeing and Calico Printing" and translations of treatises on metallurgical and chemical technology. Sir William was knighted in 1904 and was the recipient of many honors from scientific societies in Europe. He was married in 1856 to Ellen, daughter of W. Humphrey. His wife died in 1916.

MR. HARRY E. HOLLISTER died in Newark, N. J., on March 29. He was born in Newark on Nov. 29, 1887, and was graduated from the Newark Technical School in June, 1907. At the outbreak of the war he offered his services and was assigned to important duties in the development and construction of the large government powder plant at Nitro, W. Va. An article describing his work in this connection appears in this issue of this magazine. For several years he practiced his profession of chemical engineer, designing and building numerous chemical plants and developing several patented chemical apparatus and processes. Upon the cessation of hostilities he became associated with the Leonard Construction Co., New York, and was stricken while developing, on a commercial basis, one of his most valuable processes. At one time he was connected with Lockwood-Greene & Co., Boston, Mass., industrial engineers, and resigned to accept a position as assistant engineer with Harrison Bros. Co., Philadelphia, paint and chemical manufacturers, where he had charge of the design and construction of extensive chemical and paint manufacturing improvements. Later he was appointed chief engineer of the Kalbperry Corporation, New York, chemical engineers, and the Franklin H. Kalbfleisch Co., New York, chemical manufacturers.

Current Market Reports

The Non-Ferrous Metal Market

Saturday, April 12.—Prices on the non-ferrous metal market have not materially changed since our last report and demand has slackened to some extent.

Aluminium:—Conditions are unusually quiet, as aluminium has not declined. Ingots 98-99 per cent, 31c. lb. Sheets, 18 gage and heavier, 42c. Powder, 0.70-1.40 lb.

Antimony:—Wholesale lots are offered from 6¾ @ 7c. and jobbing at 7¼c. There was a slight improvement in buying.

Copper:—Moderate activity with slightly improved prices over our last report. The closing price was 15¼ @ 15⅝c. per lb.

Copper sheets, hot-rolled	lb.	$0.22½—	.....
Copper sheets, cold rolled	lb.	.23½—	.....
Copper bottoms	lb.	.30½—	.....
Copper rods	lb.	.19½—	.....
Copper wire	lb.	.17½—	$0.18
High brass wire and sheets	lb.	.18 —	.....
High brass rods	lb.	.17½—	.....
Low brass wire and sheets	lb.	.18½—	.....
Low brass rods	lb.	.21½—	.....
Brazed brass tubing	lb.	.29½—	.....
Brazed bronze tubing	lb.	.33½—	.....
Seamless copper tubing	lb.	.28 —	.....
Seamless bronze tubing	lb.	.29½—	.....
Seamless brass tubing	lb.	.30 —	.....
Bronze (gold) powder	lb.	1.00 —	.....

Lead:—Prices have declined to 4.75c. per lb. in East St. Louis and 4.975c. per lb. in New York. Sheet lead, 7¾ @ 8c. per lb.

Tin:—The fixed price of 72½c. will remain until the 10,000-ton allotment is liquidated, which will be from sixty to ninety days yet.

Zinc:—Spelter has slightly improved in price and the East St. Louis price closed at $125 per ton. Zinc dust 14c.; sheet zinc, 11c. per lb.

OTHER METALS

Bismuth	lb.	$3.20 —	$3.65
Cadmium	lb.	1.40 —	.....
Cobalt	lb.	2.50 —	3.50
Magnesium	lb.	1.75 —	2.10
Mercury	75 lb.	67.00 —	70.00
Nickel	lb.	.40 —	.45
Tungsten	lb.	Nominal	
Iridium	oz.	175.00 —	.....
Palladium	oz.	115.00 —	120.00
Platinum	oz.	99.00 —	100.00
Silver	oz.	1.01½—	.....

The Iron and Steel Market

The situation arising from the refusal of the Railroad Administration to place orders based upon the reduced prices recommended by the Industrial Board and effective

March 21 has been very generally misrepresented. It has been made to appear that the director general was refusing to do team work that he ought to do, for the general good, and his stand for the conservation of the public funds has not been placed to his credit. While the steel producers desire to obtain as high prices as possible for their products, some of them frankly commend the director general for his attitude, recognizing that he was endeavoring to do his duty.

As to the conflict between the statements of costs submitted by the steel producers to the Industrial Board and the attitude of the Railroad Administration that it can buy steel at lower prices if left to itself, this is all a question of overhead. There was a statement made, for instance, that the cost of producing bessemer rails in January was $46, but production was very light and necessarily a large overhead was charged.

There was undoubtedly a great difference of opinion between the steel producers and the Redfield board as to the demand that could be expected for steel. In vouchsafing but moderate reductions in steel prices, the reductions of March 21, together with those of last December, making an average of $11 a net ton from the Government schedule, not considering rails, the steel producers probably expected relatively light operations for several months. The Redfield board expected, undoubtedly, a fairly large demand for steel. If there were a large demand, the overhead would be so distributed that considerably lower prices could be accepted and still leave large profits, and the profits for 1919 will be taxed much less heavily than were those of 1918.

Sentimental Influences

It has been made to appear in many quarters that railroad buying would of itself produce much more activity in the steel trade. That is not true. The heaviest railroad buying that could possibly be expected, considering the uncertain position of the railroads, their light traffic and their earnings at very much below the Government guarantee, would amount to very little, in point of tonnage, to the steel trade. The hope was that if the Railroad Administration should buy with apparent freedom the public would then be moved also to buy, and its buying would furnish the really important tonnage. The public, however, had already given an inkling of its attitude as to the price reductions of March 21. Immediately after the reductions were announced there was a mild spurt in orders, but clearly this represented simply the orders that had been held back in anticipation. Now, when the total of bookings for the month of March can be scrutinized by the steel producers, they find that the spurt in buying did not make up for the previous lull, as compared with the buying rate in January.

It was expected that if the Railroad Administration endorsed the steel price reductions offered it would first buy rails, since rails are needed for upkeep. Cars and locomotives might follow, but it is not certain additional cars and locomotives will be needed in the near future. Improvements, by way of bridges, buildings, new lines, etc., would be farther in the future, and the undertaking of a comprehensive program would be of doubtful expediency when the disposition of the railroads has not been settled, or the conditions under which they will operate if, as seems altogether probable, they will be returned to their owners.

As to rail orders furnishing a stimulus to the steel industry, however, there were two unfortunate circumstances. Using open-hearth rails for illustration, bessemer rails being uniformly $2 less, the railroads had bought rails only at the $30 price which ruled up to May 1, 1916, then at $35, and then at the $40 price which became effective late in 1916. These were base prices, there being premiums for particularly stringent specifications. Last September the War Industries Board had approved a $57 price for open-hearth rails, which price obtained in various settlements for rails bought to prosecute the war, but the Railroad Administration never accepted the price. When, therefore, the Redfield board "reduced" rails from $57 to $47, it was asking the railroads to pay an advance. It is understood there is still due the railroads about 500,000 tons of rails at the basis price of $40 or less, on which shipments have been going out at the rate of 40,000 tons a week, which would carry the roads, in general, to July 1. It has not been shown that the railroads desire to lay rails at the rate of more than 40,000 tons a week. Thus in this matter of business being stimulated by the Railroad Administration buying rails there were two awkward circumstances—that what amounted to an advance in price was being asked, and that there was a fair supply of rails.

When the steel industry's capacity is fully 36,000,000 gross tons of finished steel products a year, the buying of a few hundred thousand tons more or less of rails cannot have much direct effect. The sentimental effect would be very considerable, perhaps, but that has not been proved. When the subject was so thoroughly aired it became certain that even should arrangements eventually be perfected whereby the Railroad Administration would buy, the sentimental effect would be lost. Accordingly sentiment has been growing in the steel trade that an open market is the only recourse, prices being allowed to go where they will. There is a disposition also toward a changed view in the matter of wages. With light operations the earnings of the men are very considerably reduced, and wage reductions might be effected without much complaint arising. Reasons that are largely sentimental in character are responsible both for the strenuous desire of Washington officials that wages be not reduced and for the equally strenuous desire of many steel producers that they be reduced. The latter would like to see reductions in order to preserve appearances, on account of repeated claims that steel prices could not be reduced unless wages were reduced.

The view that there should be an open market in steel is very far from universal, but it is growing more common. It is, perhaps, the optimistic view rather than the pessimistic. It looks to the possibility that an important volume of demand can thus be brought out. The other view is that demand cannot be materially stimulated and that prices should therefore be maintained, because of the high overhead per ton when operations are light.

Among the merchant furnaces the view has become quite general that there should be an open market, but pig iron is different from steel. The blast-furnaces have always had more or less competition between districts, and the recommended price schedule, which is simply $7.25 reduction from the Government schedule, with its complicated basings, entirely out of line with the alignments maintained by competition before Government price control began, must necessarily be unsatisfactory to one district if it proves satisfactory to another. The merchant furnaces feel that the way to reduce costs is to blow out, and many are doing so. Really competitive bidding cannot come, of course, until there is at least a moderate volume of inquiry, and thus far there has been practically none.

Production

Steel ingot production in 1918 is now reported by the American Iron and Steel Institute at about 43,027,000 gross tons, against 43,619,200 tons in 1917 and 41,401,917 tons in 1916. Since the middle of 1917 monthly reports of ingot production have been made by 29 companies. In 1916 these companies had made 88.14 per cent of the total output. In 1917 they made 85.1 per cent of the total, and completion of the 1918 total now shows that they made only 83.5 per cent of that year's output. This explains why the 1918 production proves to be slightly larger than had been indicated by previous estimates, based on the showing of the 29 companies. The estimates of rates of production in January and February of this year must also be revised. Reports are now made by 30 companies, which made 84.03 per cent of the 1918 total. On the basis of this 84.03 per cent, and counting the number of steel working days in the months and year, the country's rate of steel ingot production has been as follows: January, 42,600,000 tons, or 86.9 per cent of capacity, taken at 49,000,000 tons a year; February, 41,700,000 tons, or 85.1 per cent; March, 37,900,000 tons, or 77.3 per cent.

Even the March rate, although 11 per cent under the January rate, seems high in view of the generally reported stagnation in trade. The explanation offered by mills is that they are running chiefly on old orders, and they do not seem to expect new orders to take the place of old orders as they are worked out.

The Chemical Market

COAL-TAR PRODUCTS. — Producers generally report a marked increase in the volume of business for coal-tar products, although buyers are seemingly not disposed to bring their full demands in the market and seem to be confining their purchasing to immediate needs, but even this condition is having no effect in the steady increase in business. Consumers are becoming more reconciled to the market conditions, in view of the recent decline in prices, which appear to be more in accordance with their ideas. Producers are looking forward to an early resumption of activities and state they are well satisfied with the developments, apparently brought about, in part, by the settlement of the textile labor troubles, and this trade seems to be gradually becoming more active in purchasing dyes, which reflects materially on the crude and intermediate situation.

Phenol:—Considerable stock is reported to be changing hands, but second hands who were holding large quantities seem to be well sold up and the market has firmed up very noticeably.

Benzol: — Comparatively large quantities are reported being sold and second hands seem to have little if any material to offer, which tends to keep the market steady, and manufacturers are firmly maintaining prices.

Toluol: — Producers report a satisfactory business passing, but individual sales generally represent small lot transactions. Prices are quotably unchanged and the market is on a firmer basis.

Benzoate of Soda: — Resale offerings are still liberally made and in consequence lower prices have been brought about. The acid continues to be considerably neglected and keener competition among second hands has brought about some radical reductions in prices.

Alpha Naphthylamine:—Prices are firmly maintained by producers, despite the quietness generally prevailing.

Benzidine:—No important changes. The market is fairly active and steady at the recent decline in prices. There is a fair demand for the base product for export purposes, while local requirements are of moderate proportions and no particular interest is noted for the sulphate variety.

Beta Naphthol: — A fairly active trading is evident for the various grades, but available material is more than sufficient for the current call. However, no price changes have been effected, with a rather steady market prevailing.

Beta Naphthylamine:—Quotations for both the technical and refined products are held steady by producers, who report a fair volume of business passing, but the demand is by no means pressing.

Diethylaniline:—Large quantities are available at present, with new producers having recently entered the market. While the demand is slightly better, there are sufficient stocks for additional business and prices are lower.

Dimethylaniline:—There is not a great deal of business passing, despite the fact that offerings are made at some rather low levels and small lot trading continues to feature the market.

Naphthalene: — Buyers are displaying no unusual interest, but a fairly steady movement is reported at present, for the ball material, the activity being created by the drug trade, but trading even in this direction seems to be somewhat restricted. Some cheap offerings occasionally appear in the resale market, but trading for the most part is direct and manufacturers are making no price concessions to stimulate additional business.

Orthonitrophenol:—Trading is confined to small lots and stocks seem to have accumulated to a very noticeable extent, with offerings among second hands being made at 3c. to 5c. below manufacturers' prices.

Paranitrophenol:—While consumption requirements are of no unusual proportions, offerings are none too liberally made, but available supplies seem to be more than sufficient for the current call and the sales noted are closed at some low levels.

Paranitraniline: — Quantities of this material have now appeared on the market and keener competition among second hands has brought about some cheap offerings. Manufacturers are striving to keep the market steady and have not altered their prices since the recent decline.

HEAVY CHEMICALS.—Trading in the general market reflected a little more confidence in the ultimate betterment of conditions, although stocks in most instances are more than sufficient for the call. The bulk of the business is in limited quantities, but repeat orders are more frequent. Second hands are still, for the most part, the only factors actually doing anything in the way of active business, while manufacturers are seemingly not disposed to meet the resale market prices, but state a satisfactory business is developing and see no necessity for making any effort to meet this situation. Caustic soda and soda ash, the barometers of the heavy chemicals, seem to have been subject to a better call, particularly caustic soda, for which some important sales have been consummated for export purposes, and prices have been firmly maintained. On the other hand, no unusually large transactions were reported for soda ash, although trading has been of sufficient volume to take the slack off the market.

Soda Ash: — The consuming trade seems to be steadily taking a fair portion of supplies, but buyers are apparently not interested in any forward stocks and there seems to be sufficient spot material to meet the current call. Bag material from the warehouse was sold at $1.50 per 100 lb., with offerings made at this figure in some directions, but other quotations range up to $1.55 and $1.60. Double bags in the Middle West were nominally quoted at $2.15, while barrels ex store were as low as $1.60, with other directions holding at from $1.70 to $1.75.

Caustic Soda: — While the demand is not of a pressing nature there seems to be more interest on the part of buyers, and sales of 100 and 200 tons seem to have been more frequent at prices ranging from $2.75 to $2.80 f.a.s. per 100 lb. Second hands, who seem to control the market for the most part, were offering ex-warehouse material at from $2.65 to $2.70 and were offering on a basis of $2.75 to $2.80 f.a.s. Ground caustic continues to be neglected, with material available at 3½c. per pound.

Bleaching Powder: — There has been no increase in the interest for this commodity, particularly for local consumption, where buying seems to be conducted on a hand-to-mouth basis, while export trading seems to be somewhat more active. Large domestic drums were offered in the resale market at $1.60 ex-dock, and first hands are quoting this figure, at the works. Export drums were offered by second hands at 2½c. f.a.s., with manufacturers holding at 2½c.

Bicarbonate of Soda:—The continued absence of any important demand has had its effect in the market and some resale lots were reported sold as low as $2.25. This, however, is not regarded as representative of the market, as material in barrels, in most directions, was held at $2.50 per 100 lb., while that in kegs was offered at from $2.65 to $2.70.

Bichromate of Soda:—Very little business. In fact, the market is so dull that reports are still heard of further reductions in prices. For instance, there were offerings of spot material as low as 10c. for some of the standard brands, while others were quoting 10¼c. to 10½c.

Caustic Potash: — Recent price reductions seem to have had some effect in stimulating business, although the present rate of absorbing stocks is having no effect, as the production of the material is reported to be quite heavy. Some grades of the 88-92 product are offered as low as 40c., with others still holding at 48c.

Cyanide of Soda: — There has been little in the way of active trading; however, the production of the commodity is confined to a few quarters, therefore prices are firmly maintained at from 30c. to 31c., according to quantity.

Copper Sulphate: — Little in the way of any important sales are noted and small lot transactions continue to feature the market. The production is probably heavier than for some time past and prices are easier at 7c. for outside brands, with other grades of the large crystals 99% being quoted at 7¼c.

Chlorate of Soda: — The continued absence of any important demand has had its effect of a weakening market, with price reductions noted in most directions. Sales were reported as low as 15c., although 17c. to 18c. seems to be the general market quotation.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET APRIL 8, 1919

Acetic anhydride	lb.	.65	—	.70
Actone	lb.	.15½	—	.16
Acid, acetic, 28 per cent	cwt.	3.25	—	3.40
Acetic, 56 per cent	cwt.	6.50	—	6.75
Acetic, glacial, 99½ per cent, carboys	cwt.	13.00	—	14.00
Boric, crystals	lb.	.13½	—	.15
Citric, crystals	lb.	1.20	—	1.22
Hydrochloric, (22%)	cwt.	2.50	—	3.00
Hydrofluoric, 30 per cent, in barrels	lb.	.08	—	.08½
Lactic, 44 per cent	lb.	.12½	—	.13
Lactic, 22 per cent	lb.	.05½	—	.06
Molybdic, C. P	lb.	6.90	—	7.40
Nitric, 36 deg	lb.	.06	—	.07
Nitric, 42 deg	lb.	.07½	—	.08
Oxalic, crystals	lb.	.29	—	.30
Phosphoric, 47-50 per cent paste	lb.	.07½	—	.10
Phosphoric, ref. 50 per cent	lb.	.26	—	.30
Picric	lb.	.50	—	.60
Pyrogallic, resublimed	lb.	2.70	—	3.20
Sulphuric, 60 deg. works	ton	12.00	—	13.00
Sulphuric, 66 deg. works, tank cars	ton	17.00	—	20.00
Sulphuric, oleum (fuming), tank cars	ton	22.00	—	25.00
Tannic, U. S. P., bulk	lb.	1.40	—	1.50
Tartaric, crystals	lb.	.86½	—	.87
Tungstic, per lb. of WO_3	lb.	1.60	—	1.75
Alcohol, sugar cane, 188 proof	gal.	4.85	—	4.90
Alcohol, wood, 95 per cent	gal.	1.28	—	1.30
Alcohol, denatured, 180 proof	gal.	.40	—	.42
Alum, ammonia lump	lb.	.04½	—	.05½
Alum, chrome ammonium	lb.	.17½	—	.18
Alum, chrome potassium	lb.	.16½	—	.18½
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.10	—	.12
Aluminium sulphate, technical	lb.	.01½	—	.02½
Aluminium sulphate, iron free	lb.	.02½	—	.03½
Ammonia aqua, 26 deg., carboys	lb.	.07	—	.08½
Ammonia, anhydrous	lb.	.30	—	.35
Ammonium carbonate	lb.	.13	—	.14
Ammonium nitrate	lb.	.16	—	.17
Ammonium sulphate, domestic	lb.	.05	—	.05½
Amyl acetate	gal.	3.50	—	3.75
Arsenic, white	lb.	.09½	—	.10
Arsenic, red	lb.	.35	—	.40
Barium carbonate, 99 per cent	ton	80.00	—	90.00
Barium carbonate, 97-98 per cent	ton	65.00	—	67.00
Barium chloride	ton	70.00	—	80.00
Barium sulphate (blanc fixe, dry)	lb.	.03½	—	.04
Barium nitrate	lb.	.10	—	.11
Barium peroxide, basis 70 per cent	lb.	.30	—	.32
Bleaching powder, 35 per cent chlorine	100 lb.	1.60	—	2.25
Borax, crystals, sacks	lb.	.07½	—	.07¾
Brimstone, crude	ton	28.00	—	35.00
Bromine, technical	lb.	.55	—	.60
Calcium acetate, crude	lb.	.04	—	.05
Calcium carbide	lb.	.05½	—	.06½
Calcium chloride, 75 per cent, fused, lump	ton	35.00	—	43.00
Calcium peroxide	lb.	1.50	—	1.70
Calcium phosphate	lb.	.22	—	.23
Calcium sulphate, 98-99 per cent	lb.	.09	—	.09½
Carbon bisulphide	lb.	.07	—	.08
Carbon tetrachloride, drums	lb.	.14	—	.15
Carbonyl chloride (phosgene)	lb.	.75	—	1.00
Caustic potash, 88-92 per cent	lp.	.40	—	.45
Caustic soda, 76 per cent	100 lb.	2.60	—	2.75
Chlorine, liquid	lb.	.08	—	.10
Cobalt oxide	lb.	1.60	—	1.65
Copperas	lb.	.01½	—	.02½
Copper carbonate	lb.	.31	—	.32
Copper cyanide	lb.	.65	—	.70
Copper sulphate, 99 per cent, large crystals	lb.	7.00	—	7.25
Cream of tartar, crystals	lb.	.56	—	.58
Epsom salt, bags, U. S. P	100 lb.	2.25	—	2.35
Formaldehyde, 40 per cent	lb.	.22	—	.22½
Glauber's salt	lb.	.01½	—	.02
Glycerine, bulk, C.P	lb.	.16½	—	.17
Iodine, resublimed	lb.	4.25	—	4.30
Iron oxide	lb.	.06	—	.08
Lead acetate, white crystal	lb.	.12½	—	.14
Lead arsenate (paste)	lb.	.15	—	.18
Lead nitrate, C. P	lb.	.85	—	.86
Litharge, American	lb.	.09½	—	.10½
Lithium carbonate	lb.	1.50	—	.....
Magnesium carbonate, technical	lb.	.15	—	.16
Nickel salt, single	lb.	.14	—	.15
Nickel salt, double	lb.	.12	—	.13
Phosgene (see carbonyl chloride)	lb.	.75	—	1.00
Phosphorus, red	lb.	.75	—	.80
Phosphorus, yellow	lb.	.35	—	.40
Potassium bichromate	lb.	.35	—	.36
Potassium bromide, granular	lb.	1.25	—	1.26
Potassium carbonate, calcined, 85-90 per cent	lb.	.17	—	.18
Potassium chlorate, crystals	lb.	.39	—	.41
Potassium cyanide, 98-99 per cent	lb.	Nominal		
Potassium iodide	lb.	3.75	—	3.80
Potassium muriate, 80-85 p. c. basis of 80 p. c.	ton	200.00	—	250.00
Potassium nitrate	lb.	.26	—	.30
Potassium permanganate, U. S. P	lb.	.65	—	.75
Potassium prussiate, red	lb.	.85	—	.95
Potassium prussiate, yellow	lb.	.45	—	.55
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal		
Rochelle salts	lb.	.46½	—	.48
Salammoniac, gray gran	lb.	.14	—	.16
Salammoniac, white gran	lb.	.12	—	.13
Sal soda	100 lb.	1.60	—	2.00
Salt cake	ton	12.00	—	14.00
Silver cyanide, based on market price of silver	os.	.....		.....
Silver nitrate	os.	.62½	—	.63½
Soda ash, 58 per cent, light, flat (bags)	100 lb.	1.50	—	1.55
Soda ash, 58 per cent, dense, flat	100 lb.	2.45	—	3.00
Sodium acetate	lb.	.07½	—	.08
Sodium bicarbonate, domestic	lb.	.02½	—	.02¾
Sodium bicarbonate, English	lb.	.....	—	.....
Sodium bichromate	lb.	.12	—	.14
Sodium bisulphite, powd	lb.	.05	—	.07
Sodium chlorate	lb.	.16	—	.18
Sodium cyanide	lb.	.30	—	.31
Sodium fluoride, commercial	lb.	.14	—	.15
Sodium hyposulphite	100 lb.	3.25	—	3.75
Sodium molybdate, per lb. of Mo	lb.	2.50	—	.....
Sodium nitrate, 95 per cent	100 lb.	4.07½	—	.....
Sodium nitrite	lb.	.13	—	.14
Sodium peroxide	lb.	.25	—	.30
Sodium phosphate	lb.	.03½	—	.03¾
Sodium prussiate, yellow	lb.	.18	—	.22½
Sodium silicate, liquid (60 deg.)	lb.	.05	—	.05
Sodium sulphide, 30 per cent, crystals	lb.	.02	—	.02½
Sodium sulphide, 60 per cent, fused	lb.	.04	—	.05½
Sodium sulphite	lb.	.05½	—	.06½
Strontium nitrate	lb.	.25	—	.30
Sulphur chloride, drums	lb.	.07½	—	.09
Sulphur dioxide, liquid, in cylinders	lb.	.10	—	.12
Sulphur, flowers, sublimed	100 lb.	3.05	—	3.15
Sulphur, roll	100 lb.	2.70	—	3.10
Sulphur, crude	ton	35.00	—	37.50
Tin bichloride, 50 deg	lb.	.27½	—	.28
Tin oxide	lb.	.65	—	.70
Zinc carbonate	lb.	.18	—	.20
Zinc chloride	lb.	.13½	—	.14
Zinc cyanide	lb.	Nominal		
Zinc dust, 350 mesh	lb.	.12	—	.13
Zinc oxide, American process, works	lb.	.09	—	.12
Zinc sulphate	lb.	.03½	—	.04

Coal Tar Products (Crude)

NOTE—The following prices are for original packages in large quantities:

Anthracene, 80% in drums (100 lb.)	lb.	$0.90	—	$1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.22	—	.27
Benzol, 90%, in drums (100 lb.)	gal.	.22	—	.27
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.....
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.02	—	.....
Cresylic acid, 95-97%, dark, in drums	gal.	.92	—	.....
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.....
Dip oil, 25% tar acids, car lots, in drums	gal.	.38	—	.....
Phenol, U. S. P. drums (dest.), (240 lb.)	lb.	Nominal		
Pyridin	gal.	$2.50	—	.....
Naphthalene, crushed in bbls. (250 lb.)	lb.	.08½	—	.....
Solvent naphtha, water white, in drums, 100 gal.	gal.	.20	—	.25
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.18	—	.20
Toluol, in tank cars	gal.	.22	—	.....
Toluol, in drums	gal.	.23	—	.30
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal	gal.	.32	—	.40
Xylol, commercial, in tank cars	gal.	.30	—	.....

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	—	1.10
Alpha naphthol, refined	lb.	1.20	—	1.25
Alpha naphthylamine	lb.	.45	—	.50
Aniline oil, drums extra	lb.	.24	—	.25
Aniline salts	lb.	.32	—	.34
Anthracene, 80 per cent	lb.	.50	—	.55
Benzaldehyde (f.f.c.)	lb.	1.30	—	1.50
Benzidine, base	lb.	1.00	—	1.15
Benzidine, sulphate	lb.	.95	—	1.00
Benzoic acid, U. S. P	lb.	1.15	—	1.20
Benzoate of soda, U. S. P	lb.	1.10	—	.....
Benzyl chloride	lb.	.50	—	.....
Beta naphthol benzoate	lb.	5.50	—	6.00
Beta naphthol, sublimed	lb.	.65	—	.....
Beta naphthylamine, sublimed	lb.	2.50	—	2.55
Dichlorbenzol	lb.	.15	—	.20
Diethylaniline	lb.	2.25	—	2.75
Dinitrobenzol	lb.	.30	—	.35
Dinitrochlorbenzol	lb.	.30	—	.35
Dinitronaphthaline	lb.	.45	—	.55
Dinitrotoluol	lb.	.40	—	.50
Dinitrophenol	lb.	.32	—	.34
Dimethylaniline	lb.	.55	—	.60
Diphenylamine	lb.	.70	—	.75
H-acid	lb.	2.10	—	2.15
Metaphenylenediamine	lb.	1.55	—	1.75
Monochlorbenzol	lb.	.12	—	.14
Naphthalene, flake	lb.	.07	—	.08
Naphthalene, balls	lb.	.10½	—	.11½
Naphthionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.40	—	.45
Nitro toluol	lb.	.55	—	.60
Ortho-amidophenol	lb.	6.00	—	7.00
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-toluidine	lb.	.45	—	.50
Ortho-nitro-toluol	lb.	.45	—	.50
Para-amidophenol, base	lb.	3.25	—	3.65
Para-amidophenol, H. C. L	lb.	3.25	—	3.75
Para-dichlor-benzol	lb.	.15	—	.20
Paranitraniline	lb.	1.15	—	1.25
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	3.15	—	3.25
Para toluidine	lb.	1.70	—	1.75
Phthalic acid anhydride	lb.	2.50	—	3.00
Phenol, U. S. P	lb.	7.00	—	8.00
Resorcin, technical	lb.	4.50	—	5.00
Resorcin, pure	lb.	7.00	—	8.00
Salicylic acid, U. S. P	lb.	.30	—	.35
Salol	lb.	.95	—	1.00
Sulphanilic acid, crude	lb.	.25	—	.31
Toluidine	lb.	2.15	—	2.25
Toluidine-mixture	lb.	.80	—	1.00

Waxes

Prices based on original packages in large quantities.

Bayberry	lb.	$0.40	—	$0.41
Beeswax, natural crude, yellow	lb.	.36	—	.39
Beeswax, refined, yellow	lb.	.40	—	.42
Beeswax, white, pure	lb.	.65	—	.68
Candelilla	lb.	.29	—	.30
Carnauba, flor	lb.	.82	—	.85
Carnauba, No. 1	lb.	.80	—	.81
Carnauba, No. 2, regular	lb.	.65	—	.70
Carnauba, No. 2, North Country	lb.	.55	—	.57
Carnauba, No. 3, North Country	lb.	.42	—	.44
Carnauba, No. 3, chalky	lb.	.42	—	.44
Cresin, yellow	lb.	.16	—	.17

Cresin, white	lb.	.16 —	.18
Japan	lb.	.12½ —	.14
Montan, crude	lb.	Nominal	
Montan, bleached	lb.	Nominal	
Ozokerite, crude	lb.	Nominal	
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.08 —	.08½
Paraffine waxes, crude scale, 117-119 m.p.	lb.	.08 —	.08½
Paraffine waxes, crude scale, 124-126 m.p.	lb.	.08 —	.08½
Paraffine waxes, refined, 118-120 m.p.	lb.	.10 —	.11
Paraffine waxes, refined, 123-125 m.p.	lb.	.10½ —	.11
Paraffine waxes, refined, 128-130 m.p.	lb.	.11 —	.11½
Paraffine waxes, refined, 130-132 m.p.	lb.	.11½ —	.12
Paraffine waxes, refined, 133-135 m.p.	lb.	.12 —	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	.13 —	.14
Stearic acid, single pressed	lb.	.16 —	.17
Stearic acid, double pressed	lb.	.18 —	.....
Stearic acid, triple pressed	lb.	.19 —	.21
Spermaceti, block	lb.	.30 —	.31
Spermaceti, cake	lb.	.31 —	.32

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lbs.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$0.68
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.45
Pine tar oil, ref., sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.33
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.58
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.	.61
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.24
Hardwood oil, f.o.b. Mich., sp. gr., 1.06-1.08	gal.	.24
Pinewood creosote, ref.	gal.	.48

Naval Stores

The following prices are F.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$11.95 —	$12.20
Rosin E-I	280 lb.	11.95 —	12.35
Rosin K-N	280 lb.	13.00 —	14.00
Rosin W. G.-W. W	280 lb.	14.25 —	14.50
Wood rosin, bbl.	280 lb.	12.25 —	.....
Spirits of Turpentine	gal.	.77½ —	.78
Wood Turpentine, steam dist	gal.	.72 —	.....
Wood Turpentine, dest. dist.	gal.	.67½ —	.....
Pine tar pitch, bbls.	200 lb.	8.00 —	8.25
Tar, kiln burned, bbl. (500 lbs.)	bbl.	12.50 —	13.50
Retort tar, bbl	280 lb.	13.50 —	14.50
Rosin oil, first run	gal.	.68 —	.78
Rosin oil, second run	gal.	.70 —	.80
Rosin oil, third run	gal.	.82 —	.83
Rosin oil, fourth run	gal.	.85 —	.95

Vegetable Oils

Unless otherwise noted, the following prices are f.o.b., New York.

Castor oil, No. 3, in bbls.	lb.	$0.21 —	$0.23
Castor oil, AA, in bbls.	lb.	.24 —	.25
China wood oil, in bbls.	lb.	.18½ —	.20
Cocoanut oil, Ceylon grade, in bbls	lb.	.14 —	.15
Cocoanut oil, Cochin grade, in bbls.	lb.	.15 —	.17
Corn oil, crude, in bbls.	lb.	.16½ —	.17½
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½ —	.....
Cottonseed oil, summer yellow	gal.	.22 —	.....
Cottonseed oil, winter yellow	gal.	.23½ —	.24
Linseed oil, raw, car lots	gal.	1.50 —	1.52
Linseed oil, raw, tank cars	gal.	1.45 —	1.48
Linseed oil, boiled, car lots	gal.	1.53 —	1.55
Olive oil, commercial	gal.	2.25 —	2.50
Palm, Lagos	lb.	.20 —	.....
Palm, bright red	lb.	.18 —	.19
Palm, Niger	lb.	.15 —	.16
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.16 —	.18½
Peanut oil, refined, in bbls.	lb.	.19½ —	.21
Rapeseed oil, refined, in bbls.	gal.	1.50 —	1.65
Rapeseed oil, blown, in bbls.	gal.	1.55 —	1.65
Soya bean oil (Manchurian), in bbls., N. Y.	lb.	.14½ —	.15
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12¼ —	.12½

Miscellaneous Materials

All Prices F.o.b., N. Y.

Barytes, domestic, white, floated	ton	$30.00 —	$36.00
Barytes, off color	ton	22.00 —	27.00
Blanc fixe, dry	lb.	.03½ —	.04½
Blanc fixe, pulp	ton	30.00 —	45.00
Casein	lb.	.17 —	.19
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.04½ —	.06
Chalk, English, dense	lb.	.04 —	.05
China clay (Kaolin), imported, lump	ton	35.00 —	.....
China clay (Kaolin), imported, powdered	ton	60.00 —	.....
China clay (Kaolin), domestic, lump	ton	15.00 —	20.00
China clay (Kaolin), domestic, powdered	ton	35.00 —	40.00
Feldspar	ton	11.00 —	15.00
Fluorspar, acid grade, lump, f.o.b. mines	net ton	3 .00 —	37.00
Fluorspar, acid grade, ground, f.o.b. mines	net ton	40.00 —	45.00
Fuller's earth, domestic, powdered	ton	30.00 —	40.00
Fuller's earth, imported, powdered	ton	.....	.....
Graphite, domestic	lb.	.08 —	.14
Graphite, Ceylon	lb.	.08 —	.18
Graphite, Madagascar	lb.	.10 —	.15
Graphite, Mexican	lb.	.01½ —	.03½
Pumice stone, imported	lb.	.03 —	.06
Pumice stone, domestic	lb.	None	
Shellac, TN	lb.	.46 —	.47
Shellac, D.C	lb.	.75 —	.....
Shellac, V. S. O.	lb.	.72 —	.75
Shellac, Diamond I	lb.	.72 —	.....
Shellac, orange, fine	lb.	.52 —	.56
Shellac, orange, superfine	lb.	.54 —	.55
Shellac, A.C. garnet	lb.	.46 —	.50
Shellac, bleached, bone dry	lb.	.50 —	.56
Shellac, bleached, fresh ground	lb.	.46 —	.....
Soapstone	ton	15.00 —	25.00
Talc, domestic	ton	20.00 —	60.00
Talc, imported	ton	Nominal	

Refractories

Following prices are f. o. b. works:

Chrome brick	net ton	$120.00 at Chester, Penn.
Chrome cement	net ton	65.00 at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	40–30 at Clearfield, Penn.
Clay brick, 2nd quality	net ton	38–48 at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50–35.50 at Chewalah, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–90 at Chester, Penn.
Silica brick	net ton	45–55 at Mt. Union, Penn.

Ferro-alloys

Resales and overstocks make above prices approximate.

All prices f. o. b. works.

Ferro-titanium, carbon free	lb.	$0.40 —	.....
Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$300.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.32 —	.40
Ferro-chrome, per lb. of Cr. contained, 2 [illegible]% carbon	lb.	.70 —	.....
Ferro-manganese, 70-80% Mn	gross ton	130.00 —	150.00
Spiegeleisen, 16-20% Mn	gross ton	40.00 —	50.00
Ferro-molybdenum, per lb. of Mo	lb.	3.00 —	3.50
Ferro-silicon, 50%	gross ton	90.00 —	115.00
Ferro-silicon, 75%	gross ton	150.00 —	175.00
Ferro-silicon, 10-15%	gross ton	50.00 —	60.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	1.30 —	1.50
Ferro-uranium, 35-50% of U	lb.	7.00 —	.....
Ferro-vanadium, 30-40%, per lb. of contained V.	lb.	5.50 —	7.00

Ores and Semi-finished Products

Chrome ore, 35-40%, Cr_2O_3	unit	Nominal	
Chrome ore, 48% and over	unit	$1.00 —	$1.25
Coke, foundry, f.o.b. mines	net ton	4.50 —	.....
Coke, furnace, f.o.b. mines	net ton	3.75 —	.....
Petroleum coke, f.o.b. Atlantic seaboard	net ton	16.00 —	16.50
Fluorspar, gravel, f.o.b. mines	net ton	18.50 —	20.00
Manganese ore, 45% Mn and over	unit	.85 —	.....
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	70.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75 —	.85
Tungsten, Scheelite, 60% WO_3 and over per unit of WO_3	unit	9.00 —	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	7.00 —	10.00
Uranium oxide, 96%	lb.	..... —	.....
Vanadium pentoxide, 99%	lb.	6.00 —	.....
Pyrites, foreign, lump	unit	.17 —	.....
Pyrites, foreign, fine	unit	.17 —	.....
Pyrites, domestic, fine	unit	.14 —	.....
Ilmenite, 50% TiO_2	net ton	30.00 —	.....
Rutile, 95% TiO_2	net ton	160.00 —	.....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	3.00 —	3.25

Resales and overstocks make above prices approximate.

Plant Materials and Supplies

In carload lots, New York, unless otherwise stated.

BUILDING MATERIALS

Portland cement, at dock, without bags	bbl.	$1.30
Lump lime, common, including container	300 bbl.	2.65
Common brick, at dock	M.	15.00
Hollow building tile, At factory, Perth Amboy, N. J., 8x12x12	M.	194.40
Hollow building tile, At factory, Perth Amboy, N. J., 12x12x12	M.	291.60
Yellow pine, 3x4 to 8x8, 20-24 ft. long	M.	39.00
Yellow pine, 3x4 to 8x8, 20-24 ft. long at Chicago	M.	38.50
Yellow pine, 3x4 to 8x8, 20-24 ft. long at St. Louis	M.	35.00
Roofings, tar felt (14 lb. per 100 sq.ft.)	ton	52.00
Roofings, tar pitch (in 400-lb. bbl.)	ton	19.00
Roofings, asphalt pitch	ton	36.00
Roofings, asphalt felt	ton	67.50
Roofings, slate-surfaced shingles, per roll of 108 sq.ft.		2.10
Roofings, slate-finished shingles, 100 sq.ft.		5.50
Linseed oil, raw in barrels	gal.	$1.58
Linseed oil, 5 gal. cans	gal.	1.73
Red lead, dry, 100 lb. keg	lb.	.13
Red lead, in oil, 100 lb. keg	lb.	.14½
Red lead, dry, 5 lb. cans	lb.	.15
Red lead, in oil, 5 lb. cans	lb.	.16½
White lead, dry and in oil, 100 lb. keg	lb.	.13
White lead, dry and in oil, 25 and 50 lb. kegs	lb.	.13½
White lead, dry and in oil, 5 lb. cans	lb.	.15

STRUCTURAL STEEL, MILL, PITTSBURGH

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.66
Rivets, structural, ½-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ½-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.35
Sheets, No. 10 blue annealed	100 lb.	3.55
Sheets, No. 28 galvanized	100 lb.	5.70

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

POWER HOUSE SUPPLIES

In standard quantities

Hose, Fire Underwriters' 2½-in., in 50-ft. lengths	ft.	$0.75
Hose, air, ¾-in., first grade	ft.	.55
Packing, rubber and duck for low pressure	lb.	.90
Packing, asbestos for high pressure	lb.	1.60
Packing, duck and rubber for piston	lb.	1.00
Babbitt metal, best grade	lb.	.87
Babbitt metal, commercial	lb.	.42
Wiring supplies, New York:		
Friction tape, ¾-in., 100 lb. lots	lb.	.48
Rubber tape, ¾-in., 100 lb. lots	lb.	.60
Wire solder, 100 lb. lots	lb.	.46
Soldering paste, 2 oz. cans Nokorode	doz.	1.20

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Arizona

BISBEE—The Phelps-Dodge Corp. plans to resume work on concentrator.

CLIFTON—The city voted $150,000 bonds for the construction of sanitary sewers and treating plant. A. J. Kerr, town engineer.

GLOBE—The Iron Cap Mines Co. is having plans prepared by D. Cole for a mill.

JEROME—The United Verde Extension Mining Co., 233 Broadway, New York City, N. Y., plans to build extensions and additions to its copper smelter, here. G. Kingdon, general manager.

PRESCOTT — The Arizona Binghamton Mining Co. is having plans prepared by D. Cole for the construction of a mill and tramway. Estimated cost, several hundred thousand dollars.

Arkansas

ASHDOWN—The United Oil Mills plans to build a 2-story, 130 x 160-ft. oil mill and will require equipment for same. W. Foster, president.

LITTLE ROCK—The Dixie Cotton Oil Co., east of North Little Rock, will install a 12-press mill, in connection with the 2-story, 60 x 240-ft. oil mill which it plans to build. Total estimated cost, $250,000. W. F. Birdville, general manager.

California

LOS ANGELES—The Hollywood Studios, Inc., 6980 Hollywood Blvd., has awarded the contract for the construction of a motion picture plant, on Santa Monica Blvd., to the Milwaukee Building Co., Wright & Callender Bldg.; plans include the installation of film developing rooms. Total estimated cost, $250,000.

Connecticut

HARTFORD—The Board of Water Commissioners has awarded the contract for building a slow sand filtration plant, to the Foundation Co., 233 Broadway, New York City. Estimated cost, $627,508.

HARTFORD — The Hartford Rubber Works, 691 Park Ave., plans to build a 1-story, 60 x 80-ft. addition to its rubber factory on Booth Ave. Estimated cost, $18,000.

Idaho

QUARTZBURG—The Gold Hill & Iowa Mines Co. plans to build a mine plant, to include a mill, concentrators, cyanide plant, etc., and is in the market for cyanide machinery. Estimated cost, $300,000. E. E. Carter, superintendent.

Illinois

CHICAGO—E. H. Frommann, architect, 64 West Randolph St., is receiving bids for the construction of a 2-story, 125 x 200-ft. factory on Cortland and Kilbourne Sts., for the National Enameling & Stamping Co., 346 West Kinzie St. Estimated cost, $85,000.

ROCK ISLAND — C. W. Scott, 1338 2nd Ave., Davenport, Ia., has awarded the contract for the construction of a 1-story, 40 x 150-ft. factory for galvanizing to K. H. Cox, 905 Kirkwood Blvd., Davenport, Ia. Estimated cost, $3500.

Kansas

TREECE—The Big Elk Mining Co. plans to move Dorris mill from Quapaw and erect same at Treece, and is in the market for gas engine, rolls, rock drills and tables. C. Kelly, superintendent.

WESTVILLE—The Lucky Jew Mining Co., Commerce, Okla., plans to build a concentrating plant here. E. Depree, superintendent.

Kentucky

LOUISVILLE—The C. C. Stoll Oil Co., Shelby and River Sts., plans to build a refinery.

Louisiana

NEW ORLEANS — The New Orleans Petroleum Co., Woolworth Bldg., New York City, will build an oil refinery 15 miles from here. Estimated cost, $1,500,000. Work will be done by day labor.

Maryland

BALTIMORE — The Baltimore Copper Smelting & Rolling Co., 4th and 5th Aves., plans to build an addition to its plant.

HANCOCK—The Maryland Glass Sand Co., Hagerstown, plans to build a mill near here. Estimated cost, $50,000. R. J. Funkhouser, president.

Massachusetts

ASHLAND—The United States Color & Chemical Co., 15 Custom House, Boston, has awarded the contract for the construction of a 2-story, 50 x 84-ft. research building here, to the Pennsylvania Tile & Construction Co., 45 Milk St., Boston. Estimated cost, $50,000. Noted Feb. 15.

Michigan

DETROIT — The Central Forge Co., Euclid Ave., has awarded the contract for the construction of a 2-story, 70 x 302-ft. heat-treating plant and a 2-story, 70 x 302-ft. forge shop, on Euclid Ave. and Grand Trunk Railway tracks, to the Whitehead & Kales Iron Works, Beecher Ave. and Michigan Central R. R.

Missouri

ST. JOSEPH—The Conser Laundry Co., 908 Francis St., is in the market for one water softening plant, oil burners and a 12,000-gal. oil tank, etc. H. S. Lewis, chief engineer.

ST. LOUIS — The Mineral Refining & Chemical Co., Iron Mountain tracks and Des Pere River, plans to build an addition to its paint and pigment plant. Mineral milling equipment will be installed in same. Total estimated cost, $500,000. A. E. F. Versen, c/o owner, engineer.

ST. LOUIS—G. W. Niedringhause, 3745 Lindell St., vice president of the National Enameling Stamping Co.; C. Studebaker of the Studebaker Corp., 4300 Forest Park Bldg., and others plan to build a coke pig iron plant at Granite City. Estimated cost, $7,000,000.

ST. LOUIS—The Yawitz Dyeing & Cleaning Co., Suburban and Whittier Sts., will install a chemical laboratory in the 1- and 2-story, 50 x 135-ft. dyeing and cleaning factory, which it plans to build on Delmar and Walton Sts. Estimated cost, $50,000. S. Yawitz, president.

WACO—The Freehold Oil & Gas Co. plans to build a mill at its No. 3 shaft. W. S. Marquiss, manager.

WACO—C. Windbigler, Joplin, plans to move Old Jasper County mill from Prosperity and erect same at Waco, and is in the market for pumps, rock drills, belting and hoist. Estimated cost, $50,000. C. Windbigler, manager.

WEBB CITY—The Carlat Mining Co. plans to remodel and enlarge its plant, and is in the market for boilers, gas engine, rolls and belting. C. Cornett, manager.

Montana

BUTTE—The Boston & Montana Development Co., Daly Bank Bldg., plans to build a concentrator, and is in the market for complete concentrating equipment, coarse and fine crushing tables, etc. Estimated cost, $150,000. J. D. Pope, superintendent.

New Jersey

MILLVILLE—The Eastern Potash Co., 120 Broadway, New York City, plans to build a factory on the banks of the Raritan River here. Estimated cost, $2,000,000.

NEWARK—The General Leather Co., 420 Frelinghuysen Ave., has awarded the contract for the construction of a 2-story, 38 x 64 ft. drying building, to E. M. Waldron, Inc., 665 Broad St. Estimated cost, $14,000.

NEWARK—Nickelsburg Bros. Co., Meadow St. and Lincoln Highway, is having plans prepared by O'Rourke & Briscoe, architects, 45 Clinton St., for the construction of a 3-story, 50 x 100-ft. plant. Estimated cost, $30,000. Miller & Moran Chemical Works, lessees.

NEWARK—The Radel Leather Manufacturing Co., Wilson Ave., has awarded the contract for the construction of a 1-story, 40 x 110-ft. factory on Wilson Ave. and Central R. R. tracks, to the Reynolds Construction Co., 308 South 9th St. Estimated cost, $5000.

NEWARK—The Weldon Roberts Rubber Co., 117 Mechanics St., has awarded the contract for altering the 3-story, 56 x 112-ft. factory at 18 Oliver St., to Oschwald & Schmidt, 845 Broad St. Estimated cost, $10,000.

PHILLIPSBURG—The City Commissioners have approved $150,000 bond issue for the construction of a new sewer and sewage oxidation plant. C. E. Tilton, city engineer.

PHILLIPSBURG—The City Commissioners voted $65,000 bond issue for the construction of a sewage disposal plant and sewer lines. C. E. Tilton, city engineer.

New York

BROOKLYN—The Brooklyn Maternity Hospital, 670 Bushwick Ave., will install a chemical laboratory in the 4-story, 75 x 100-ft. hospital which it plans to build on Bushwick Ave. and Adams St. Total estimated cost, $70,000. M. Duckman, treasurer. Carlson & Wiseman, 226 Henry St., architect.

BUFFALO—The Mentholatum Co., 146 Seneca St., will soon award the contract for the construction of a 5-story, 100 x 160-ft. factory on the corner of Niagara and Brace Sts. Estimated cost, from $150,000 to $200,000.

COBLESKILL—D. D. Frisbie, president of the Board of Trustees, Schoharie State School of Agriculture, at the office of the Commissioners of Agriculture, State and Lodge Sts., will soon award the contract for the construction of a 2-story, 40 x 70-ft. school; plans include the installation of two laboratories. Estimated cost, $50,000.

CORTLAND—J. B. Webster, 3 Main St., and others have purchased the Redway Garage on Groton Ave., and will install an acetylene plant, metal working machinery, drill press, planer, miller, etc.

FREDONIA—The Bone Dry Lime Co. plans to build a plant for the manufacture of agricultural lime from the Cassadaga Lake marl, near here. Lime burning equipment, rock crushers, etc., will be installed in same. C. E. Smith, Franklin, president.

GOUVERNEUR—The Nestles Food Co. plans to remodel and reconstruct the plant which it purchased from the International Milk Products Co. last season. Additional equipment will be installed in same. Estimated cost, $100,000.

JAMESVILLE—The Farmers' Consumers Carbide Co., recently incorporated by F. M. Hennessey, 3rd National Bank Building, Syracuse, and others with $125,000 capital, plans to establish furnaces and calcium plant here. Estimated cost, $25,000.

LONG ISLAND CITY—The Famous Players-Lasky Corp., 485 5th Ave., New York City, has awarded the contract for the construction of a 3-story, 90 x 120-ft. laboratory and a 4-story, 100 x 200-ft. studio on Pierce, Graham, 5th and 7th Aves., to the Fleischmann Construction Co., 531 7th Ave., New York City. Estimated cost, $2,000,000.

LONG ISLAND CITY—The General Carbonic Co., 444 Van Brunt St., Brooklyn, has awarded the contract for the construction of a 1-story factory on 6th St. and West Ave., to the Austin Co., 217 Broadway, New York City. Plans include the installation of a chemical laboratory. Estimated cost, $200,000.

NEWARK—The city voted $280,000 bonds to build a gravity water supply system. Work includes pipe line involving 1750 tons of cast-iron pipe, 1,000,000 gallon rapid sand filtration plant, earth dam and dike, etc. J. P. Wells, Cutler Building, Rochester, consulting engineer.

NIAGARA FALLS—The Defiance Paper Co., Walnut and 3rd Sts., plans to build an addition to its pulp mill. Pulp grinders, rotary screens, etc., will be installed in same. Estimated cost, $18,000.

Ohio

CLEVELAND—The Harshaw, Fuller, Goodwin Co., Electric Bldg., has awarded the contract for the construction of a 1-story, 30 x 50-ft. addition to its varnish factory at 1002 Howard St., to the Hunkin-Conkey Co., 601 Century Bldg. Estimated cost, $15,000.

CLEVELAND—The Reflex Ignition Co., Superior Bldg., has awarded the contract for

the construction of a 2-story, 80 x 160-ft. factory on West 110th St. and N. Y. C. Railway, to S. W. Emerson Co., 1900 Euclid Bldg. Estimated cost, $65,000.

COLUMBUS—The Atlantic Refining Co., Hartman Bldg., plans to build a refinery.

COLUMBUS—The Columbus Pharmacal Co., 332 Oak St., plans to build a 3-story, 43 x 84-ft. factory. Estimated cost, $55,000. O. Darst, Brunson Bldg., archt.

MAUMEE—The State Board of Health has ordered the city to have plans prepared for a sewage disposal plant or trunk sewer, to connect with Lucas Co. sewerage system to eliminate discharge of sewer into Maumee River. G. Champe, 610 Nasby Bldg., Toledo, engineer.

Oklahoma

CLAREMORE—The city plans election soon to vote on $82,000 bonds for sewer improvements, to include the construction of a sewage disposal plant, sanitary sewer extensions, etc.

EUFAULA—The city plans election soon to vote on $40,000 bonds to extend and improve the waterworks system, to include the installation of a Pittsburgh filtering plant at the pumping station as well as a 12-in. intake pipe.

Oregon

ASTORIA—The Astoria Pulp & Paper Co. has awarded the contract for the construction of a 40 x 250-ft. addition to its pulp and paper mill on 11th St. and Taylor Rd., to P. Trullinger. Estimated cost, $25,000. Noted Mar. 1.

CORVALLIS—The State Legislature has appropriated $60,000 for the construction of a 2-story, 56 x 220-ft. engineering laboratory at the Oregon Agricultural College here. J. V. Bennes, architect, Chamber of Commerce Bldg., Portland, preparing plans.

Pennsylvania

BETHLEHEM—The Traveler Tire & Rubber Co., 819 North Broad St., Philadelphia, plans to build a 2-story, 60 x 250-ft. rubber mill here. Estimated cost, $250,000. J. O. Hunt, 114 North Montgomery St., Trenton, N. J., architect.

CLARENDON—The Union Petroleum Co., Widener Bldg., Philadelphia, plans to rebuild the portion of its refining plant here recently destroyed by fire.

MONESSEN—The city plans to build an incinerating plant. A. J. Knight, president of the City Council.

Texas

FT. WORTH—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of an argon production plant here, to the Dawson Construction Co., 810 Union Trust Bldg. Estimated cost, $431,000. (180 days.)

FT. WORTH—The Creosoting Lumber Corp. plans to build a creosoting plant here, to have an initial capacity of 5000 barrels. Estimated cost, $75,000. E. Morrel, secretary.

STEPHENVILLE—The Duke Consolidated Oil Co. plans to build an oil refinery.

Virginia

NORFOLK—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until April 21 for the construction of a galvanizing and oxy-acetylene plant here. Estimated cost, $108,000. Specification No. 3772.

West Virgina

MARTINSBURG—X. Poole and others plans to build dehydrating plant for apple products and is in the market for machinery for same.

Wisconsin

SHEBOYGAN—R. L. Frome, Howards Grove, has awarded the contract for the construction of a 2-story, 35 x 80-ft. glue factory on Calumet Drive, to R. Eisman. Estimated cost, $6500.

British Columbia

SLOCAN—M. S. Davys plans to improve existing plant and install a new concentrator. Estimated cost, $120,000.

Ontario

GUELPH—The Partridge Rubber Co., Ltd., Metcalfe St., plans to build a 3-story, 60 x 100-ft. factory. Estimated cost, $60,000. James, Loudon & Hertzberg, Excelsior Life Bldg., Toronto, engineers.

OTTAWA—The Ottawa Gas Co., Sparks St., plans to build a water-gas plant on Lees Ave., East Ottawa. Estimated cost, $850,000. A. A. Dion, 35 Sparks St., superintendent.

OWEN SOUND—W. Kennedy & Sons, 1114 1st Ave., West, plans to build an addition to its steel plant, to include the installation of equipment for two cupolas for smelting iron and elevators. Estimated cost, $85,000.

TIMMONS—The Hollinger Mines plans development, to include the construction of a plant and the installation of machinery. Estimated cost, $500,000. E. F. Brigham, engineer.

Quebec

TEMISKAMING—The Kipawa Co. plans to build pulp and paper mills. Estimated cost, $5,000,000. G. T. Lamb, Montreal, engineer.

Cuba

HAVANA—The Cuban Air Reduction Co., 120 Broadway, New York City, plans to build a 2-story, 98 x 108 ft. acetylene plant here. Estimated cost, $100,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting at 29 S. LaSalle St., Chicago, May 13 and 14.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 22nd annual meeting at Atlantic City, N. J., June 24-27. The headquarters will be at the Hotel Traymore.

THE AMERICAN ZINC INSTITUTE will hold its annual meeting at St. Louis, Mo., June 9-10, instead of May 12, as announced in our April 1 issue.

THE NATIONAL FOREIGN TRADE COUNCIL will hold its sixth national foreign trade council at the Congress Hotel, Chicago, Ill., on Thursday, Friday and Saturday, April 24, 25 and 26, 1919.

THE NATIONAL SERVICE COMMITTEE of the Engineering Council will hold a meeting at Chicago, Ill., April 23 to 25.

Industrial Notes

Organization of Electric Furnace Association

At a meeting held at Niagara Falls on March 21 and 22 an organization was perfected to promote the use of electric-furnace products. The organization is known as the Electric Furnace Association and comprises manufacturers of electric furnaces, electrical apparatus, electric-furnace supplies and accessories, designers and inventors of electric-furnace equipment and the users of electric furnaces. The purpose of the organization is to lay before the consumers of electric-furnace products the advantages of those materials. Special emphasis was laid on electric steel, the tonnage of which showed remarkable increase throughout the world during the last four years.

The meeting was attended by representatives of the General Electric Co., Westinghouse Electric and Manufacturing Co., American Metallurgical Corp., Industrial Electric Furnace Co., T. W. Price Engineering Co., Booth-Hall Co., Hamilton & Hansell, Ludlum Electric Furnace Co., Pittsburgh Electric Furnace Co., FitzGerald Laboratories, Carborundum Co., Norton Co. and Acheson Graphite Co.

A permanent organization was created with the following officers: President, Acheson Smith, Acheson Graphite Co., Niagara Falls; first vice-president, C. H. Booth, Booth-Hall Co., Chicago; second vice-president, W. E. Moore, Pittsburgh Electric Furnace Co., Pittsburgh; secretary, C. G. Schluederberg, Westinghouse Electric & Manufacturing Co., Pittsburgh; treasurer, F. J. Ryan, American Metallurgical Corp., Philadelphia; directors, the officers and C. A. Winder, General Electric Co., Schenectady, and F. J. Tone, Carborundum Co., Niagara Falls.

Committees were created as follows: Publicity: C. H. Booth, chairman, C. A. Winder, C. G. Schluederberg and A. B. Oatman. Data: W. E. Moore, chairman, J. A. Seede, A. M. Williamson, F. J. Ryan, F. A. J. FitzGerald and C. A. Vom Baur. Fields: F. T. Snyder, chairman, F. J. Tone, H. A. DeFries and S. L. Walworth.

The second meeting was held in New York April 3, at which the tentative draft of the constitution and by-laws was adopted. An aggressive campaign for members was planned to include all manufacturers of electric furnaces, electric-furnace supplies, electric steel, electric brass, electric power and designers and inventors of furnaces.

THE STURTEVANT MILL CO., Boston, Mass., announces the establishment of new offices, at Room 619 Singer Bldg., 149 Broadway, N. Y. C. These offices are in charge of the company's former Western sales manager, Mr. J. S. Vrabek, recently promoted to the position of Eastern sales manager.

THE NEWARK TECHNICAL SCHOOL, Newark, N. J., announces a special course in corporate chemistry by Dr. Frederic Dannerth. The aim will be to show the application and the principles of industrial chemistry to manfacturing problems. It will cover:

1. Sources of raw materials.
2. Executive departments, purchasing, manufacturing and selling.
3. Advisory departments, engineering, law and research.
4. Laboratory management.
5. Economic office organization management.

Further details can be obtained from Mr. D. R. Hodgdon, director.

A. P. GREEN FIRE BRICK CO., Mexico, Mo., has opened an Eastern district sales office at 30 Church St., New York City. Mr. Howard C. Thayer, formerly field mechanical engineer for the J. G. White Corp. at the U. S. Nitrate Plant No. 2, is in charge.

THE STEPHENS-ADAMSON MFG. CO. of Aurora, Ill., has recently established a new sales office in Cincinnati, Ohio, to give attention to this particular territory. Mr. John G. Stewart, who has been associated with the Stephens-Adamson Manufacturing Co. for fifteen years, had been appointed district manager.

CHARLES F. AMES CO., 90 West St., New York City, has been appointed to act as the New York sales department of the Platt Iron Works, Dayton, Ohio.

THE PHOENIX IRON WORKS CO., Meadville, Pa., has opened a New York office, Room 619, Fifth Ave. Bldg., in charge of Mr. J. E. Kindregan and Mr. Paul C. Rodgers. Mr. Kindregan continues representing this company as district sales manager, with an office in the Harrison Bldg., Philadelphia, Pa., and will devote only a part of his time in the company's interest at New York. In addition to the New York territory, Mr. Rodgers will also continue the representation of the company at Boston.

MR. HERMAN A. HOLZ has moved his office and laboratories to the Pullman Bldg., 17 Madison Ave., New York City. The laboratories will contain equipment for experimental heat-treating, hardness and impact testing, micro- and macro-photographic investigation of metal sections, apparatus for magnetic measurements and for investigating the mechanical properties of steel products by determination of their correlated magnetic characteristics, also equipment for X-ray work on metal products.

THE ISLAND REFINING CO., a subsidiary of the Island Oil & Transportation Co., has been formed to refine the oil of the latter company, which has a potential production of 35,000,000 bbl. of oil per year. Col. G. A. Burrell of Pittsburgh, Pa., has been elected president of the new company.

THE U. S. COPPER PRODUCTS CO., Cleveland, Ohio, has placed an order with the General Electric Co., Schenectady, N. Y., for a brass-melting furnace of the muffled arc type having a capacity of 2200 lb. per hour.

THE ASPROMET CO. of Pittsburgh, Pa., announces that the name of the company has been changed to the H. H. Robertson Co.

OSAKA BOEKI KAISHA, LTD., Osaka, Japan, solicits correspondence with American dealers in chemicals and metals with the object of securing Japanese and Korean representation of American lines.

JOSEPH BOUKEZ & CIE, Alexandria, Egypt (address P. O. Box 604), general importers specializing in chemicals, iron and steel, cement and building materials, desire representation of American lines.

THE W. A. JONES FOUNDRY & MACHINE CO., of Chicago, Ill., manufacturers of power transmission apparatus, special foundry and machine work and also the Jones spur gear speed reducer, have opened an Eastern office at 30 Church St., New York, under the direction of Mr. Lemuel C. Biglow, who formerly for a number of years held a similar position with the Morse Chain Co., of Ithaca, New York.

THE METAL & THERMIT CO., New York City, is issuing a large map calendar showing the new railroad time zones in the United States which went into effect Jan. 1, 1919.

THE AIR REDUCTION SALES CO., New York, at the organization meeting of directors held Feb. 19, 1919, elected the following officers: Mr. A. S. Blagden, president; Mr. A. R. Ludlow, vice-president; Mr. C. E. Adams, treasurer; Mr. M. W. Randall, secretary; Mr. C. L. Snow, assistant treasurer; Mr. C. C. Emerson, assistant secretary.

THE NATIONAL ANILINE & CHEMICAL CO., New York, held its annual meeting of stockholders and a subsequent meeting of directors on Feb. 17 and 19 respectively. Officers and directors were elected as follows: President and chairman of the board, William J. Matheson; vice-presidents, Dr. William Beckers, Robert Alfred Shaw and Dr. L. C. Jones; acting treasurer, William H. West; assistant treasurers, H. S. Trott and T. S. Baines; secretary, William T. Miller; assistant secretary, Walter E. Rowley; chairman of executive committee, Henry Wigglesworth. The personnel of the board is as follows: Dr. William Beckers, New York; H. H. S. Handy, Syracuse; Dr. L. C. Jones, Syracuse; Clinton S. Lutkins, New York; William J. Matheson, New York; Eugene Meyer, Jr., New York; W. N. McIlravy, New York; F. M. Peters, New York; T. M. Rianhard, New York; Robert Alfred Shaw, New York; I. Frank Stone, New York; Dr. P. C. Taggesell, Buffalo; Orlando F. Weber, New York; Henry Wigglesworth, New York.

DR. EMIL E. LUNGWITZ, chemical and industrial engineer, 90 West St., New York City, has opened an office at 14 East Jackson Blvd., Chicago, Ill., under the management of Mr. H. L. Dick.

THE EPPING-CARPENTER PUMP CO., Pittsburgh, Penn., announces the appointment of Mr. F. S. Healey as manager of sales in addition to his former office of chief engineer. Mr. F. F. Woods is now located in New York as Eastern sales manager. Mr. Albert A. Scheuch of the sales department has been appointed as assistant sales manager, and Mr. Paul D. Goodman, formerly of the McClary Jemison Machinery Co. of Birmingham, Ala., has been added to the sales personnel.

THE BROWN-STEEL CO., Columbus, Ohio, has been incorporated to take over the steel department of the Columbus Mill & Mine Supply Co. of that city.

THE BECKWITH MACHINERY CO., Arch St. and Parkway, Northside, Pittsburgh, has opened an office and warehouse at 1227 West 9th St., Cleveland, for the sale of the regular lines of mine, mill and construction equipment marketed by this company.

BARZILLAI G. WORTH, vice-president of Walter Kidde & Co., Inc., has been elected treasurer of the Monmouth Chemical Co., also having charge of manufacturing and research. This company produces potassium chlorate electrolytically, using processes and apparatus developed by Walter Kidde & Co., Inc., under Mr. Worth's direction. During the war and at the instance of the United States Government Mr. Edward Schwarz, chemical engineer of the Kidde organization, succeeded in developing for the Monmouth Chemical Co. a new bromate-free chlorate product surpassing the German standard. This was done in co-operation with the work of the Ordnance Department to eliminate the causes for ammunition failures reported to Congress in the early stages of the war by Secretary Baker.

THE HYDRO ELECTRIC POWER COMMISSION, Ontario, Can., placed an order with the Westinghouse Co., for two 45,000 k.v.a. vertical water-wheel generators of 12,000 volts, 3-phase, 25-cycles, for their Queenstown development. These will be the largest water-wheel generators ever constructed.

THE ATMOSPHERIC CONDITIONING CORP. of Philadelphia, Penn., is the new name of the organization which, after Apr. 1, will manufacture and market the air conditioning apparatus and the Webster system of humidifying control formerly handled by the Braemer Air Conditioning Corp. The equipment includes Webster air washers, humidifiers, dehumidifiers, generator coolers, etc. The officers of the new corporation are: Mr. John F. Hale, president; Mr. William J. Strandwitz, vice-president; Mr. Herbert A. Terrell, secretary and treasurer; Mr. E. Nesdahl, chief engineer. Mr. Warren Webster, president and general manager of Warren Webster & Co., is a member of the board of directors. Territorial officers are already established in many of the larger cities of the United States and Canada and also in London, England.

New Publications

Tycos Tables is a publication recently gotten out by the TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y. This new edition gives general data concerning and for use with temperature indicating, recording and controlling instruments; hydrometers and meteorological instruments. Price, $1.00.

NEW BUREAU OF STANDARDS PUBLICATIONS: Scientific Paper No. 332. Preliminary determination of the thermal expansion of molybdenum. By Lloyd W. Schad and Peter Hidnert; Circular No. 78. Solders for aluminium; Technologic paper No. 118, A critical study of the Ledebur method for determining oxygen in iron and steel. By J. R. Cain and Earl Pettijohn.

NEW BUREAU OF MINES PUBLICATIONS: Tech. Paper 196. Notes on the black sand deposits of Southern Oregon and Northern California. By R. R. Hornor; Bull. 172. Abstracts of current decision on mines and mining. By J. W. Thompson; War Minerals Investigations Series No. 9, Problems involved in the concentration and utilization of domestic low-grade manganese ore. By Edmund Newton.

THE MINES EXPERIMENT STATION AND ITS RELATION TO THE IRON MINING INDUSTRY OF MINNESOTA. Published by the School of Mines, University of Minnesota, Minneapolis, Minn., Feb., 1919.

MANGANESE AND CHROMIUM IN CALIFORNIA. By Walter W. Bradley, Emile Huguenin, C. A. Logan, W. Burling Tucker and Clarence A. Waring. Bulletin 76, dated August, 1918, published by the California State Mining Bureau, San Francisco, Calif.

QUICKSILVER RESOURCES OF CALIFORNIA. By Walter W. Bradley of the California State Mining Bureau. This is Bulletin No. 78, and is the first work published in 15 years dealing distinctly with quicksilver and its metallurgy. It includes an account of the original investigations on concentration of quicksilver. Copies may be obtained for $1.50 postpaid, from the State Mining Bureau, Ferry Bldg., San Francisco, Calif.

THE FEDERAL BOARD FOR VOCATIONAL EDUCATION is issuing a series of "Opportunity Monographs," dealing with various forms of employment for disabled soldiers and sailors. The purpose of the series is to give these men the information that will assist them in choosing a vocation. Monographs have been published on the following subjects: Series No. 6, Safety and Fire Protection Engineering; Series No. 9, Oxy-Acetylene Welding; Series No. 13, Concrete Construction and Cement Manufacture; Series No. 14, Electrical Employments with Utility Companies; Series No. 15, Electrical Construction, Maintenance, and Repair Occupations; Series No. 16, The Law as a Vocation.

CANADIAN DEPARTMENT OF MINES PUBLICATION: Preliminary Report of the Mineral Production of Canada During the Calendar Year 1918. Prepared by John McLeish, published Feb. 27, 1919.

Manufacturers' Catalogs

THE ESTERLINE CO., Indianapolis, Ind., publishes each month the "Esterline Graphic." The pamphlet on hand deals with power factor surveys, which is of special interest to central stations and industrial plants. This company will be glad to send to anyone interested information on graphic recording instruments of the portable, wall or switchboard type.

THE W. S. ROCKWELL CO., 50 Church St., New York, is distributing Bull. 41 to interested parties, upon application. This bulletin covers the subject of heating furnaces for billets, wire bars and cakes. The text and illustrations aim to give a comprehensive account of the heating operations involved, including suggestions as to the types of furnaces found best suited to various plant and manufacturing requirements.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., has published preliminary Bull. 113, illustrating and describing a steam jet air pump containing two or more steam jets working in series with a condenser between the jets. The bulletin gives engineering data on the operation of the pump.

THE SEMET-SOLVAY CO., Syracuse, N. Y., calls attention to a new catalog on Solvay protective paints. This 32-page booklet deals with crysolite protective, graphite, stack, acid-resisting and hydraulic paints, concrete coatings and general directions about the use of these materials. Price list No. 53 is supplemented with the booklet.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis.: "C-H Molded Insulation" is the title of a new 2-color, 16-page booklet which describes thermoplax and pyroplax, the trade names of the heat-resisting and fire-resisting insulations made by this company which can be molded into countless sizes and shapes for all purposes.

THE AMERICAN-LA FRANCE FIRE ENGINE CO., INC., Elmira, N. Y., has isued a Safety-First catalog, Edition D, which deals not only with the first aid to the injured, but also with resuscitation, safety signs, respirators, masks, pure air helmets and hoods, and many other appliances for the protection of workers, giving illustrations as well as descriptive matter. The "ambrine" surgical dressing is noted, first-aid equipment and cabinets are illustrated and described, also an improved stretcher and other equipment such as rubber gloves, leggings, protective suits, safety oil cans, portable lamps, etc., which devices all make for the preservation of life, health and property.

Stocks and Bonds

Closing Bid and Asked Quotations April 11, on N. Y. Stock Exchange

CHEMICAL COMPANIES

	Bid	Ask		Bid	Ask
Am.Ag.Ch.....	108½	108½	Mat.Al.Wk..	31	36
do.pf.....	100	100½	Ten. C. & C..	13½	14
Barrett Co....	131	132	Un. Dyewood.	58½	61
do.pf.....	114½	115	do. pf.....	...	96
Gen.Chem.....	173	179	Va.-Car. Ch..	60½	60½
do.pf.....	102½	104	do. pf.....	112	113
Int.Ag.Ch....	20½	21			
do. pf.....	72½	74			

Bonds

Am. Ag. Ch., 1st cv. 5s, '28.....	99	99½
Am. Ag. Ch., cv. db. 5s, '24.....	105	110
Int. Ag. Ch., 1 mtg. & col. tr. 5s, '32.....	81½	81½
Va.-Car. Ch., 1 mtg. 5s, '23.....	95½	96
Va.-Car. Ch., cv. db. 6s, '24.....	101½	102

PETROLEUM COMPANIES

	Bid	Ask		Bid	Ask
Asso. Oil Co..	75	79½	P-A Pet & Tr.	82	82½
Cal. Pet.....	25½	26	do. pf.....	143	148
do. pf.....	69½	70½	Pierce Oil....	20	20½
Col. G. & E..	45½	45½	Royal Dutch..	92	92½
Mex. Pet.....	181½	182½	Sinclair O & R	49½	49½
do. pf.....	103½	106	Texas Co.....	213½	214
Ohio Cit. Gas.	41½	41½	Tex. Pac. Ld.		
do. pf.....	...	...	Tr.....	200	230
Ohio Fuel S...	45	46	Tidewater Oil	210	215
Okla. P. & R..	10½	10½			

Bonds

Columbia Gas & Electric, 1 5s, '27.....	87	89
Col. G. & El., std. 1 5s, '27.....	83	89
Pan-Am. Pet. & Tr. 1 6s, '19-'27.....	130	
Pierce Oil, cv. db. 6s, '24.....	97½	98
Pierce Oil, cv. 5% Notes, '20.....	107½	108
Sin. O. & R. 1 In.7s, '20, with stk. war....	106	
Sin. O. & R. 1 In. 7s, '20 without stk. war..	97	97½
Texas Co., db. 6s, '31.....	103	103
Union Oil of Cal. 1 5s, '31.....	93	94
United Fuel Gas 1 mtg. 6s, ser.A, '36.....	95½	96

IRON AND STEEL SECURITIES

	Bid	Ask		Bid	Ask
Am. St. F.....	81½	82	Pitts.Ste. pf...	93	94
Beth. Steel...	75	76	Rep. Iron &		
do. class B.	75½	76	Steel.....	82½	83
do. pf., 8%.	107	107½	do. pf.....	102½	10 ½
do. pf., 7%.	95	96	Sloss Sheff. I.		
Central Fdry.	13	21	& S.....	52	55
do. pf.....	30½	34	do. pf.....	84	88
Col. F. & I....	42½	42	Superior Steel.	40	40½
do. pf.....	105	125	do. 1 pf..	97½	98½
Cruc. Steel...	67½	67½	Trans. & W.		
do. pf.....	93½	94½	Steel.....	44½	45
Great No. Ore	41½	41½	Un. Alloy St..	42½	43
Gulf Sta. Steel	53	55	U.S.C.I.P.&F.	22½	23½
do. 1 pf....	92½	98½	do. pf.....	59	60
Lack. Steel...	70½	70½	U. S. Steel....	98½	98½
Mid.St.& Ord.	47½	47½	do. pf.....	116½	116½
Nova Scotia			Va. Coal,I&C.	54	57
Steel.....	47	...			

Bonds

Beth. Steel, 1 ext. gtd. S.F. 5s, '26.....	95½	96
Beth. Steel, 1 In. ref. 5s, Ser. A, '42.....	88	99
Beth. Steel, P. M. & I. S. F. 5s, '36.....	84	85
Buff. & Susq. Iron, 1 S. F. 5s, '32.....	91	96
Buff. & Susq. Iron, deb. 5s, '27.....		
Cent. Found. 1 mtg. S. F. 6s, '21.....	78	87
Col. F. & I., gn. S. F. 5s, '43.....	89	90
Ill. Steel, db. 4½s, '40.....	83½	84
Ind. Steel, 1 mtg. gtd. 5s, '52.....	95½	96
Lack. Steel, 1 5s, '23.....	96½	96½
Lack. Ste., 1 con. mtg. cv. 5s, Ser. A, '50	88½	90½
Mid. St. & Ord., clt. cv. S. F. 5s, '36.....	88½	88½
Nat. Tube, 1 mtg. gtd. 5s, '52.....	95½	96
Rep. I. & S., S. F. mtg. 5s, '40.....	97½	94
Tenn. C. & I. R.R., gn. 5s, '51.....	91	97
U. S. Steel, S. F. 5s, '63.....	100½	100½
Va. C., I. & C., 1 5s, '49.....	85½	85½